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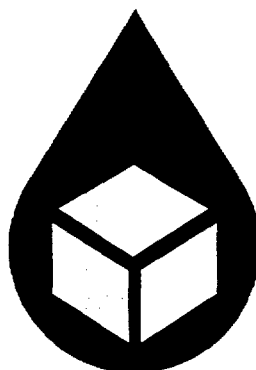
# **WEST VALLEY DEMONSTRATION PROJECT WEST VALLEY, NEW YORK**

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## **Resource Conservation and Recovery Act Facility Investigation Report Volume 1**

### **Introduction and General Site Overview**



**West Valley Nuclear Services Company, Inc.**

**and**

**Dames & Moore**

**WVDP-RFI-017**

Prepared for:  
U.S. Department of Energy  
Ohio Field Office  
West Valley Area Office

July 1997  
10282 Rock Springs Road  
P.O. Box 191  
West Valley, New York 14171-0191

# West Valley Demonstration Project

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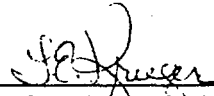
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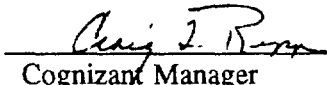
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Resource Conservation and Recovery Act  
Facility Investigation Report  
Volume 1  
Introduction and General Site Overview

West Valley Demonstration Project  
West Valley, New York

APPROVED BY  L. E. Krieger  
Cognizant Engineer

APPROVED BY  C. L. Repp  
Cognizant Manager



West Valley Nuclear Services Co., Inc.

P.O. Box 191

West Valley, NY 14171-0191

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P.O. Box 191  
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Resource Conservation and Recovery Act  
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## Acronyms

ASTM	American Society for Testing and Materials
BR	Bouwer and Rice Method (1976)
CBS	Chemical Bulk Storage
CDDL	Construction and Demolition Debris Landfill
CFR	Code of Federal Regulations
CMS	Corrective Measures Study
CO	Certificate to Operate an Air Emission Source
CPC	Chemical Process Cell
CSRf	Contact Size Reduction Facility
CSS	Cement Solidification System
DEG	Wind direction azimuth
DOE	(U.S.) Department of Energy
EE	Environmental Evaluation
EID	Environmental Information Document
EPA	(U.S.) Environmental Protection Agency
FRS	Fuel Receiving and Storage Area
GCR	General Purpose Cell Crane Room
GPC	General Purpose Cell
HLW	High-level Waste
HLWTF	High-level Waste Tank Farm
HSWA	Hazardous and Solid Waste Amendments (to RCRA)
HVAC	Heating, Ventilating, and Air Conditioning
IRTS	Integrated Radwaste Treatment System
$K_d$	Distribution Coefficient
$K_h$	Horizontal Hydraulic Conductivity
$K_v$	Vertical Hydraulic Conductivity
LLW	Low-level Waste
LLWTF	Low-level Waste Treatment Facility
LWC	Liquid Waste Cell
LWTS	Liquid Waste Treatment System
MCR	Mechanical Crane Room
MMI	Modified Mercalli Intensity
MPH	Miles per Hour
MPS	Meters per second

Acronyms (*continued*)

MRR	Manipulator Repair Room
MSL	Mean Sea Level
NDA	Nuclear Regulatory Commission-licensed Disposal Area
NESHAPs	National Emission Standard for Hazardous Air Pollutants
NFS	Nuclear Fuel Services, Inc.
NGVD	National Geodetic Vertical Datum
No <sub>x</sub>	Nitrogen Oxides
NPH	Normal Paraffin Hydrocarbon
NRC	(U.S.) Nuclear Regulatory Commission
NWS	National Weather Service
NYCRR	Official Compilation of Codes, Rules, and Regulations of the State of New York
NYSERDA	New York State Energy Research and Development Authority
NYSDEC	New York State Department of Environmental Conservation
NYSGS	New York State Geological Survey
PBS	Petroleum Bulk Storage
PC	Permits to Construct an Air Emission Source
PMC	Process Mechanical Cell
PNL	Pacific Nuclear Laboratories
PPC	Product Purification Cell
RCRA	Resource Conservation and Recovery Act
REGN	Regional tower
RFI	RCRA Facility Investigation
SAR	Safety Analysis Report
SCS	Soil Conservation Service
SDA	(New York) State-licensed Disposal Area
SFCM	Slurry-Fed Ceramic Melter
SOP	Standard Operating Procedure
SPDES	(New York) State Pollutant Discharge Elimination System
SRR	Scrap Removal Room
SST	Solvent Storage Terrace
SSWMU	Super Solid Waste Management Unit
STS	Supernatant Treatment System
SVS	Scale Vitrification System
SWMU	Solid Waste Management Unit
S <sub>y</sub>	Specific Yield
TBP	Tributyl Phosphate
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TIP	Trench Interceptor Project

Acronyms *(concluded)*

USC	United States Code
USCS	Unified Soil Classification System
USGS	United States Geological Survey
WD	Wind direction
WNYNSC	Western New York Nuclear Service Center
WS	Wind Speed
WTF	Waste Tank Farm
WVDP	West Valley Demonstration Project
WVNS	West Valley Nuclear Services Co., Inc.
XC-1,XC-2,XC-3	Extraction Cells
10M	10 meter monitoring level
60M	60 meter monitoring level

## 1.0 Introduction

### 1.1 Purpose and Objective

This Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) report has been prepared for the United States Department of Energy (DOE) Ohio Field Office DOE West Valley Demonstration Project (WVDP) to meet the requirements of Administrative Order on Consent [Docket No. II RCRA-3008(h)-92-0202] (U.S. Environmental Protection Agency 1992) for solid waste management units (SWMUs) located on the U.S. Department of Energy-operated portions of the Western New York Nuclear Service Center (WNYNSC).

The purpose and objective of the RFI is to determine the nature and extent of releases of hazardous waste or hazardous constituents as defined in section III.1 of the Administrative Order on Consent [Docket No. II RCRA-3008(h)-92-0202] (U.S. Environmental Protection Agency 1992) from SWMUs at the WVDP. Pursuant to the RFI Work Plan (West Valley Nuclear Services Co., Inc. December 1993), the primary goal of this investigation is to collect and evaluate information to determine which of the following actions are appropriate for each SWMU or super SWMU (SSWMU): no further action; a corrective measures study (CMS); or additional investigations to support one of the other actions.

The RFI is focused on determinations related to RCRA-regulated hazardous wastes or hazardous constituents only: The WVDP has reviewed existing information and performed surface, subsurface soil, and sediment sampling investigations and collected and reviewed groundwater data in order to define and assess the environmental setting, unit and waste characteristics, and potential sources, degree, and extent of nonradiological contamination.

### 1.2 RFI Scope and Approach

The scope and approach of the RFI incorporates the following seven tasks, previously identified in Attachment I of the Administrative Order on Consent:

- Task I: Description of current conditions: A description of the facility background, the nature and extent of contamination, and the interim measures that have been implemented at the WVDP are in the RFI Work Plan, WVDP-RFI-014, Rev. 0, (West Valley Nuclear Services Co., Inc. December 1993).
- Task II: Pre-investigation evaluation of corrective measure technologies: The Pre-Investigation Evaluation of Corrective Measures Technologies (U.S. Department of Energy August 3, 1993).
- Task III: RFI Work Plan requirements: This plan includes a project management plan, data collection quality assurance plan, data management plan, health and safety plan, and community relations plan. The RFI Work Plan, WVDP-RFI-014, Rev. 0 (West Valley Nuclear Services Co., Inc. December 1993), was submitted to NYSDEC and the EPA on June 9, 1993 and approved on October 5, 1993.

- Task IV: Facility investigation: A description of the environmental setting, source characterization, contamination characterization, and the identification of any potential receptors. This information is contained within RFI Volumes 1 through 10.
- Task V: Investigation analysis of data and protection standards: This information is included in RFI Volumes 2 through 10.
- Task VI: Laboratory and bench-scale studies: As described in the RFI Work Plan, laboratory and bench-scale studies, if necessary, will be part of a CMS.
- Task VII: Reports: Reports include preliminary reports and work plans, progress reports, and draft and final reports of the RFI. These are contained in Tasks I - VI above.

This volume, Volume I, Introduction and General Site Overview, is part of the effort to address Task IV. Volume I provides essential information concerning the WNYNSC. It describes the historical use of the facility for the treatment, storage, or disposal of waste, current environmental monitoring programs and permits, earlier RCRA interim measures and activities, regional and site geology, soil characteristics, surface water and sediment characteristics, air quality, and potential receptors of any possible contamination that may have been released from the SSWMUs.

The remaining volumes, volumes 2 through 10, are SSWMU-specific reports that provide information about each SSWMU, obtained through the RFI process. These SSWMU investigations encompass Tasks V and VI. Task VII is addressed in part by the individual SSWMU-specific reports that describe in detail the individual unit's location, design features, operating history, type and quantity of waste, physical and chemical characteristics of the waste, migration and dispersal characteristics of the waste, and possible contamination of groundwater, soil, surface water, sediment, and air. Where applicable, protection standards identifying federally approved New York State water, air, and soil quality standards are included in these SSWMU-specific volumes. Each volume also sets forth conclusions and recommendations.

The RFI volumes that will comprise the complete report are as follows:

- Volume 1, Introduction and General Site Overview
- Volume 2, Nuclear Regulatory Commission-licensed Disposal Area, SSWMU #9
- Volume 3, Construction and Demolition Debris Landfill, SSWMU # 8
- Volume 4, Low-level Waste Treatment Facility, SSWMU # 1
- Volume 5, Miscellaneous Small Units, SSWMU # 2
- Volume 6, Low-level Waste Storage Area, SSWMU # 6
- Volume 7, Chemical Process Cell Waste Storage Area, SSWMU # 7
- Volume 8, High-level Waste Storage and Processing Area, SSWMU # 4
- Volume 9, Maintenance Shop Sanitary Leach Field, SSWMU # 5
- Volume 10, Liquid Waste Treatment System, SSWMU # 3

Originally, thirty individual SWMUs were identified in the Administrative Order on Consent. Of these thirty, six were associated with the New York State Energy Research and Development Authority (NYSERDA) managed portion of the WNYNSC. One of the six, the bulk storage warehouse landfill, was originally identified as a WVDP SWMU, rendering twenty-five SWMUs under the management of the WVDP. Since the Administrative Order on Consent was executed, eighteen new SWMUs have been identified. Thus, a total of

forty-three SWMUs have been identified as the responsibility of the WVDP. Of these forty-three SWMUs, forty-one are located within the WVDP boundaries. Two of the SWMUs are located outside the WVDP premises but are still located on New York State-owned land.

The originally identified twenty-five SWMUs were incorporated into twelve SSWMUs as defined in the RFI Work Plan (West Valley Nuclear Services Co., Inc. December 1993). Two of the twelve SSWMUs, #10, the integrated radwaste treatment system (IRTS) drum cell and #12, the hazardous waste storage lockers, have been identified in the RFI Work Plan as requiring no further investigatory action.

Plate 1 shows the locations and boundaries of the SSWMUs; Figure 1-1 shows the locations of the individual SWMUs. Table 1-1 lists the SWMUs and indicates their investigatory status. Table 1-2 lists the SSWMUs and their constituent SWMUs.

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## 2.0 General Site Overview

### 2.1 Facility Background

#### 2.1.1 Introduction

The WNYNSC, which is near West Valley, New York and about 50 kilometers (30 mi) south of Buffalo, New York, is the location of the only commercial nuclear fuel reprocessing facility to have operated in the United States.

NYSERDA holds title to the WNYNSC for the people of the state of New York. Nuclear Fuel Services, Inc. (NFS) the commercial operator, operated the fuel reprocessing facility and the WNYNSC under Nuclear Regulatory Commission (NRC) Operating License CSF-1 from 1966 to 1972 on land leased by NFS from New York State, processing about 640 metric tons (1.4 million lbs) of spent reactor fuel. The reprocessing operation generated approximately 2.3 million liters (600,000 gal) of high-level radioactive waste that was transferred into underground tanks for storage. In 1972 NFS closed the process building for modifications to expand its capabilities but subsequently decided not to resume operations. The terms of the contract between the state and NFS required the state to assume responsibility for the facilities and wastes when NFS terminated the lease.

The Fiscal Year 1978 Authorization Act (Public Law 95-238, Section 105) instructed the DOE to study future options for the WNYNSC. DOE also was directed to recommend an allocation of existing and future responsibilities for the WNYNSC among the federal government, the state of New York, and then-current industrial participants. The resulting study, the Western New York Nuclear Service Center Study Final Report and Companion Report (U.S. Department of Energy 1982a, 1982b), identified the high-level liquid waste as having the greatest potential to adversely affect the environment.

In 1980 Congress passed the West Valley Demonstration Project Act (U.S. Congress October 1, 1980), Public Law 96-368. The West Valley Demonstration Project Act directed DOE to solidify the high-level waste in a form suitable for transportation and disposal, develop containers suitable for permanent disposal, dispose of low-level and transuranic waste from the WVDP in accordance with applicable licensing requirements, and decontaminate and decommission tanks, facilities, and any material and hardware used in connection with the WVDP in accordance with NRC requirements. In September 1981 the NRC amended the operating license to transfer exclusive use and possession of the facilities to DOE for conduct of the WVDP. (NYSERDA continues to be licensed as the owner; however, the requirements of the license are being held in abeyance during the term of DOE's exclusive use and possession.) On February 25, 1982, DOE assumed operational control of the WVDP premises of the WNYNSC in order to conduct the WVDP. The DOE is currently performing operations as stipulated in the West Valley Demonstration Project Act, the Memorandum of Understanding between the DOE and the NRC (November 19, 1981), and the Cooperative Agreement between DOE and NYSERDA (October 1980).

#### 2.1.2 Regional Setting

The WNYNSC property comprises approximately 1,335 hectares (3,300 acres) of northern Cattaraugus County, New York and approximately 6 hectares (14 acres) of southern Erie County, New York. (See Plate 1.) All active and inactive facilities are located on the Cattaraugus County portion of the WNYNSC. This area is wholly drained by Buttermilk Creek, which joins Cattaraugus Creek at the northern end of the property.

Cattaraugus Creek flows northwest into Lake Erie approximately 50 kilometers (30 mi) southwest of Buffalo, New York. Figure 2-1 shows the location of the site and the associated drainage basin.

The WVDP portion of the WNYNSC is divided into two areas, the north and south plateaus. The geology of the two areas is dissimilar and is described in detail in this volume in chapter 3.0, Environmental Setting. The operating process building and associated SWMUs are located on the north plateau. The disposal areas and the drum cell are on the south plateau.

### 2.1.3 Historical Use of the Facility for the Treatment, Storage, or Disposal of Waste

Pursuant to Section 3010 of the Hazardous and Solid Waste Amendments (HSWA) to RCRA, 42 United States Code (USC) § 6930, on October 17, 1984, DOE notified the EPA of its hazardous waste activity as a generator and requested the issuance of an EPA Hazardous Waste Identification number. Because of the presence of hazardous constituents in the leachate at the New York State-licensed disposal area (SDA) and the associated remediation and waste management activities, the EPA determined that NYSERDA was a generator of hazardous waste and an owner and operator of a hazardous waste treatment storage and disposal facility. Furthermore, in accordance with Section 3005(e) of HSWA, 42 USC § 6925(e), on June 4, 1990, DOE submitted its Part A Hazardous Waste Permit application for its hazardous treatment and storage activities at the WVDP. On June 5, 1990, NYSERDA notified the EPA of its hazardous waste activity and also filed its Part A Hazardous Waste Permit application.

The 1990 notifications identified DOE as a generator of hazardous waste and an operator of a hazardous waste treatment, storage, and disposal facility and NYSERDA as the owner of the WNYNSC as the term "owner" is used under RCRA. The EPA agreed that NYSERDA is a generator of hazardous waste due to the generation of hazardous waste leachate at the SDA.

Pursuant to Section 3005(e) of HSWA, 42 USC § 6925(e), and 40 Code of Federal Regulations (CFR) §§ 270.1(b) and 270.70 (a), DOE and NYSERDA received "interim status." Interim status facilities are subject to the regulations promulgated pursuant to Sections 3004 and 3005 of HSWA, 42 USC §§ 6924 and 6925, which are codified in 40 CFR Parts 260 - 263, 265, 268, and 270, and 6 New York Codes, Rules, and Regulations (NYCRR) Parts 370 - 373 and 376.

Various types of wastes were previously managed by NFS and some, excluding those located in the SDA, are currently managed by the WVDP. Current management includes treatment and storage of wastes as well as maintenance of areas where wastes were disposed of on-site during NFS and early WVDP operations. Plate 1 is a site map showing the location of all SSWMUs. Figure 1-1 identifies the locations of individual SWMUs.

Information gathered on the historical use of individual SWMUs and a description of the source and waste characteristics of each SWMU is presented in RFI Volumes 2 through 10. An overview of historical operations of the site is provided here.

The process building and its related support facilities are located in the middle of the north plateau. These facilities were constructed in the early 1960s on land that had been used for farming. During NFS operations the process building was used to reprocess spent nuclear fuel in order to recover uranium and plutonium.

The spent fuel assemblies were transported to the process building in heavily shielded shipping casks. At the fuel receiving and storage area (FRS), the casks were spray washed to remove road dirt and the spent fuel

assemblies were removed from the casks, placed in aluminum storage canisters, and moved into the underwater storage area to await processing.

The first step in spent fuel reprocessing consisted of a mechanical portion that separated the fittings and casings from the assemblies and then chopped the metal tubes containing the spent fuel into short pieces, 1.3 to 3.8 centimeters (0.50 to 1.50 in) long. The spent fuel was then leached out by means of nitric acid, leaving the pieces of metal tubes, which were rinsed, radiologically surveyed, containerized, and buried in the NRC-licensed disposal area (NDA).

A solvent extraction process using ten pulsed countercurrent extraction columns then recovered the uranium and plutonium leached from the spent fuel. The extractant used was a 30% solution of tributyl phosphate in a hydrocarbon solvent known as dodecane. Chemical and radiolytic decomposition products were removed from the used organic solvent by contacting it with sodium carbonate solution and then with dilute nitric acid so that the solvent could be recycled.

The aqueous waste solutions from the solvent extraction process were partially evaporated to concentrate the wastes and remove most of the nitric acid, which was subsequently recovered for reuse. The wastes were then neutralized and pumped to the waste tank farm (WTF) for storage in an underground carbon steel tank.

The process building consisted of many cells, ancillary rooms, and facilities. The three main areas included the FRS, the mechanical process cells, and the chemical process cells and equipment area where the spent fuel was dissolved and the uranium and plutonium extracted.

The cells are the subject of a draft RCRA Facility Investigation Report: Sealed Rooms Paper Characterization (West Valley Nuclear Services Co., Inc. June 1994). The following information about the process building is intended to provide an overview of the wastes that probably can be associated with SWMUs.

- The mechanical process cells contained the equipment for trimming, chopping, and general handling of the spent fuel assemblies before chemical dissolution of the fuel material. The area was divided into several cells: the process mechanical cell (PMC), the general purpose cell (GPC), and the scrap removal room (SRR). Maintenance, repair, and decontamination of the cranes and manipulators occurred in a mechanical crane room (MCR), a manipulator repair room (MRR), and a GPC crane room (GCR).
- Equipment for dissolution of the spent fuel, separation and purification of the uranium and plutonium, cleanup of used solvent, and concentration of the liquid wastes was housed in several process cells: the chemical process cell (CPC), three solvent extraction cells (XC-1, XC-2, and XC-3), the product purification cell (PPC), and the liquid waste cell (LWC).

Materials and chemicals used by NFS during reprocessing are summarized below:

<u>Process/System</u>	<u>Chemical/Material Used</u>
Chop-leach	Mild Steel $\text{Hg}(\text{NO}_3)_2$ - reportedly not used after first few runs $\text{HNO}_3$ - nitric acid
Solvent Extraction	$\text{Fe}(\text{SO}_3\text{NH}_2)_2$ - ferrous sulfamate $\text{NaNO}_2$ - sodium nitrite $\text{H}_2\text{SO}_4$ - sulfuric acid $\text{NaOH}$ - sodium hydroxide
Solvent and Treatment	Tributyl phosphate (TBP) $\text{NaCO}_3$ and $\text{HNO}_3$ - sodium carbonate and nitric acid Dodecane, $\text{C}_{12}\text{H}_{26}$ - isomers
Decontamination & Decommissioning	$\text{HNO}_3 + \text{CH}_3\text{COOH}$ - nitric acid + acetic acid $\text{NaOH} + \text{C}_4\text{H}_6\text{O}_6$ - sodium hydroxide + tartaric acid $\text{KMnO}_4$ - potassium permanganate citric acid
Zirflex Declad	$\text{HF} + \text{HNO}_3$ - hydrofluoric acid + nitric acid $\text{Al}(\text{NO}_3)_3$ - aluminum nitrate
Met-l-x Fire System	$\text{NaCl} + \text{MgCl}_2$ - sodium chloride and magnesium chloride
Lab Chemicals	Miscellaneous
Maintenance	Molykote Oils and Greases Trichloroethylene (TCE) (degreaser)

Liquid process building wastes came from the acid fractionator condensate, floor drains in various cells and chemical makeup areas, and wash solutions from decontamination operations. Regeneration solutions from past decontamination efforts in the process building were wash water and dilute acid and caustic decontamination solutions.

Between 1966 and 1972, when the reprocessing facility was operating, permitted environmental releases included atmospheric discharges from process off-gas and ventilation systems and boilers and aqueous discharges of process, utility, and sanitary wastewaters. Any off-normal releases were reported in accordance with existing license and permit requirements. Liquid high-level radioactive wastes were transferred to the high-level radioactive waste underground storage tanks. Land disposal of nonradioactive solid wastes occurred at a construction and demolition debris landfill (CDDL) at the facility. Land disposal of low-level radioactive wastes was being conducted at the SDA and in the NDA during this period.

#### 2.1.4 WVDP Site Activities and Processes

As previously noted, the purpose of the WVDP Act is to solidify high-level waste (HLW) in a form suitable for transportation and disposal and develop suitable containers for the waste for transport to a federal repository for permanent disposal. Through the WVDP Act, DOE is also directed to dispose of low-level waste (LLW) and transuranic waste from the WVDP in accordance with applicable licensing requirements and decontaminate and decommission tanks, facilities, and any material and hardware used in connection with the WVDP in accordance with NRC requirements.

DOE assumed management of the facility in 1982 and is operating it in accordance with the WVDP Act and the Memorandum of Understanding with the NRC and in agreement with guidelines and permits issued by the EPA and NYSDEC. Various waste management activities have occurred to meet the objectives of the Act, including decontamination of portions of the reprocessing facility, land disposal, treatment of low-level radioactive liquid waste via the low-level waste treatment facility (LLWTF), solidification through cementation, aboveground storage of low-level solid radioactive and mixed waste, and nonradiological test vitrification.

##### 2.1.4.1 Decontamination of the Reprocessing Facility

Decontamination of specific cells within the process building have occurred at the WVDP. Decontamination took place in order to allow existing facilities to be used for various operations required by the WVDP Act (e.g., the vitrification system, the IRTS storage of vitrified wastes).

##### 2.1.4.2 Land Disposal

The WVDP disposed of approximately 5,663 cubic meters (200,000 ft<sup>3</sup>) of wastes, containing about 625 curies, in the unused portion of the NDA from late 1982 through 1986. With the exception of four caissons, the WVDP burial area was limited to the inner section of the NDA and is surrounded on three sides by NFS disposals. The wastes disposed during WVDP's operations included Class A LLW generated during process building decontamination activities. These wastes consisted of radiologically contaminated process building equipment, protective clothing, contaminated soils, and other similar types of waste. Four of the disposals were in steel-lined caissons. The remaining wastes were disposed in the trenches. Wastes were packaged in drums and boxes and also were disposed as bulk material.

##### 2.1.4.3 Construction and Demolition Debris Landfill

The WVDP continued to operate the CDDL from 1982 through 1984. The landfill was used to dispose of nonradioactive solid waste generated during construction of the facility (Bechtel tenure), during operation of the reprocessing facility (NFS tenure), and prior to the WVDP. No wastes were disposed in the CDDL after December 1984. The facility was closed in 1985 as per specifications set forth in 6 NYCRR Part 360.

##### 2.1.4.4 Treatment Systems

The WVDP currently employs various treatment processes to support the primary treatment process of vitrification.

- The LLWTF treats low-level radioactive liquid wastewater, reducing the level of radionuclides in the effluent before disposing it via a State Pollutant Discharge Elimination System (SPDES) permitted outfall system.
- The IRTS is a series of treatment systems that process liquid wastes from the HLW tanks. The IRTS comprises the supernatant treatment system (STS), the liquid waste treatment system (LWTS), and the cement solidification system (CSS). These treatment systems process specific waste streams, creating a cement-solidified nonhazardous waste form. This waste is stored and managed in an aboveground low-level solid radioactive waste storage facility.

In addition to the IRTS, construction is currently under way at the vitrification facility, which will, upon completion, solidify the HLW contained in the HLW tanks. Vitrification of radioactive wastes is scheduled to begin in 1996.

#### 2.1.4.5 Aboveground Storage of Low-level Solid Radioactive and Mixed Waste

There are various permitted storage facilities at the WVDP used to store low-level solid radioactive, mixed wastes, and hazardous wastes. Wastes stored in these facilities have been and are generated on-site as a result of treatment systems and/or investigations that support RCRA activities.

RFI Volumes 2 through 10 provide further detailed descriptions of the decontamination activities, land disposal units, treatment systems, and aboveground storage facilities.

### 2.2 Description of Current Monitoring and Permit Requirements

The current environmental monitoring program is comprised of effluent monitoring, off-site environmental surveillance, and on-site monitoring. The WVDP environmental monitoring program, an ongoing program designed to monitor environmental releases of radioactive and nonradioactive substances from past and current site operations, meets the requirements of DOE Order 5400.1.

The program is designed to provide data on effluent air, effluent water, surface and groundwater, soils, sediments, and foods, all of which are possible pathways for movement of radionuclides, primarily from the facility to humans and the environment. This program was initiated in 1982 when DOE assumed control of the site; it has been updated over time as directed by DOE orders and directives. The program also includes monitoring performance for other regulatory purposes (i.e., SPDES, the National Emission Standard for Hazardous Air Pollutants [NESHAPs], and RCRA). Table 2-1 lists the environmental permits currently held by the WVDP.

The monitoring program includes both continuous recording of data and collection of soil, sediment, water, air and other samples at various times. The parameters analyzed under this ongoing program are radiological and chemical indicator parameters.

### 2.3 Implementation of Past RCRA Interim Measures

The NDA trench interceptor project (TIP) is defined as an interim measure in the 3008(h) Order on Consent. Mitigation measures undertaken as a precursor to the TIP interim measure are summarized below.

### 2.3.1. N-dodecane Tributyl Phosphate Mitigation Program

The migration of spent extractant wastes disposed of in the NDA was first observed in a United States Geological Survey (USGS) monitoring well within the northeast perimeter of the NDA on November 30, 1983. On that date, 4 feet of nonaqueous phase liquid was detected floating on the water in the well. Subsequent analysis determined its composition: 98% was a kerosene-like solvent and 2% was TBP. The solvent and the radioisotopes contained in the original detection wells indicated that it was spent extractant from the spent fuel reprocessing operations conducted by NFS from 1966 to 1972. The reprocessing used a solution of TBP in a normal paraffin hydrocarbon (NPH), n-dodecane, as an extractant. Because NPH (a 12-chain carbon radical) has characteristics similar to kerosene, the term "kerosene" has been used in past historical documents. However, the solvent was not, in fact, kerosene.

A detailed investigation between December 1, 1983, and February 28, 1984, to determine the source and location of the solvent migration indicated that the source was eight 3,785-liter (1,000-gal) tanks containing absorbed solvent previously disposed in NDA special holes #10 and #11 (West Valley Nuclear Services Co., Inc. 1985b). The plan to isolate and remove the solvent source proposed five work phases. Phase I (feasibility and preliminary activities) included preparing a safety analysis report (SAR) and environmental evaluation (EE), procedures, and specifications. Phase II (site preparation) included road upgrade, terrain leveling, sheet piling installation, and installing a weather shelter and a supply of temporary electric power. Phase III (investigation and liquid removal) included the removal of overburden, exhumation of tanks, and identification of the accepted technique for solidification of the contaminated solvent into a waste form for disposal. Phase IV included the solidification of the solvent. Phase V included the trench backfill, cap construction, and closure.

Preliminary activities were under way in late 1985. Full-scale stabilization operations began in early 1986 and concluded in the same year with the following accomplishments:

- Excavation of special holes #10 and #11
- Exhumation of the eight 3,785-liter (1,000-gal) tanks containing solvent-impregnated absorbent
- Removal and packaging of the contaminated absorbent and soils
- Size-reduction and packaging of all tanks for disposal
- Solidification of the contaminated solvent into a qualified waste form suitable for Class A LLW disposal (Portland cement with proprietary components)
- Backfilling and final closure of special holes #10 and #11
- Stopping the spread of the solvent plume in the NDA and, in some locations, reversing the spread
- Installation of ten new monitoring wells in other special holes suspected of containing solvent.

The entire solvent stabilization program generated approximately 272 m<sup>3</sup> (9,600 ft<sup>3</sup>) of packaged solid radioactive waste. These quantities, packaged in 2.5 m<sup>3</sup> (90 ft<sup>3</sup>) steel containers, included 227 m<sup>3</sup> (8,016 ft<sup>3</sup>) of contaminated soil, 25 m<sup>3</sup> (800 ft<sup>3</sup>) of contaminated absorbent, and 20 m<sup>3</sup> (706 ft<sup>3</sup>) of size-reduced tanks. All containers have been stored for eventual Class A LLW disposal.

The solvent collected in the NDA during these operations totaled 1,624 liters (429 gal) solidified in twenty-six 208-liter (55-gal) drums. In addition, contaminated solvent, generated from former reprocessing operations and stored in a tank on the process building's solvent storage terrace (SST), was also solidified. This quantity amounted to 8,433 liters (2,228 gal) in 135 drums, each containing 108-liters (29-gal). Approximately

568,000 liters (150,066 gal) of water were either treated in the LLWTF or discharged in full compliance with the SPDES permit.

### 2.3.2 Trench Interceptor Project

The TIP includes a trench 274 meters (975 ft) long, 4 to 6 meters (12 to 21 ft) deep, and 1.22 meters (4.0 ft) wide. Construction of the trench began in January 1990 and was completed in December 1990. The trench was designed to intercept potentially contaminated groundwater. Should contamination be encountered, a pretreatment system is available to treat the groundwater for solvent and iodine-129 contaminants. The trench surrounds the downgradient corner of the NDA and is further described in RFI Volume 2. To date, there is no evidence of hazardous constituents at the NDA interceptor trench or the downgradient monitoring wells.

### 3.0 Environmental Setting

#### 3.1 Geology

##### 3.1.1 Regional and Site Stratigraphy

###### Regional Stratigraphy

A stratigraphic column identifying the major rock units in the area and including Colton's (1961) perception of the sequence is presented in Figure 3-1. The bedrock portion is based on stratigraphic studies by Kriedler (1962), Flagler (1966), Van Tyne (1975), Wright (1973), and Zerrahn (1978). Precambrian control points are the Ellis No. 1 well, located about 20 miles west of the site, which intersected basement at -1,561 meters (-5122 ft) National Geodetic Vertical Datum (NGVD) and the K.R. Wilson No. 1 well, located about 21 kilometers (13 mi) east of the site, which bottomed in the Potsdam and in which basement was predicted to occur at -1,744 meters (5722 ft) NGVD.

Table 3-1 presents the regional stratigraphy based on the master legend that accompanies the 1970 edition of the Geologic Map of New York (Fisher et al. 1970). The master legend was edited to retain only those facies, units, and assemblages reflecting the depositional and tectonic settings that characterized the site, with the exception that numerous continental units of Middle and Late Devonian age (Devonian Clastic Sequence) were retained to indicate the pattern of deposition during development of the Catskill Delta.

Patterns on the Geologic Map of New York — Niagara Sheet (Fisher et al. 1970) indicate that the shallowest bedrock at the site is uppermost Machias. Conneaut and Conewango groups and Lower Mississippian and Lower Pennsylvanian rocks all occur to the south within 80 kilometers (50 mi) of the site.

For purposes of stratigraphic discussion, the site region extends westward and southward to the Pennsylvania border, northward to Lake Ontario, and eastward to the Finger Lakes district. Variation in the stratigraphic sequence beyond these limits is consistent with trends established within the site region — thickening of the sequence and the addition of units basinward and thinning of the sequence and the loss of units up-basin. Westward into northern Ohio, Upper Devonian gray shales and siltstones pass into sequences dominated by black shales such as the Cleveland-Chagrin-Huron sequence. Eastward, the site area sequence becomes increasingly continental in aspect and redbeds become increasingly common.

The Paleozoic strata beneath Western New York dip generally southward at about 5 m/km (less than 1°), and the sequence ranges in thickness from 600 meters (1969 ft) at the south shore of Lake Ontario to 3,600 meters (11,812 ft) at the New York-Pennsylvania border. The underlying crystalline basement slopes similarly to the south.

A detailed description of the uppermost 396 meters (1,300 ft) of bedrock at the site is contained in Bergeron (1985). This exploration — 69 USGS 1-5 — was drilled in the southeastern sector of the WNYNSC on the till plain northwest of the bulk storage warehouse. It intersected the entire Canadaway-Java-West Falls sequence and probably was completed about 40 meters (130 ft) below sea level in the Sonyea Group.

## Site Stratigraphy

The surficial geology of the WVDP is essentially as shown on LaFleur's (1979) map of the Ashford Hollow 7.5-minute quadrangle, a derivative of which is included here as Figure 3-2. As shown, the site is underlain by the Lavery till. The Lavery is covered on the north plateau and locally elsewhere by Wisconsinian fluvial deposits and by Holocene alluvium and colluvium; the Lavery is mantled on the steeper slopes by Holocene landslides and at lower levels along the principal watercourses by floodplain deposits. Bedrock exposures in the near vicinity of the WVDP also are shown in Figure 3-2 and complete the surficial map of the site.

The subsurface geology of the WVDP has been defined mainly on the basis of data generated in the drilling programs listed in Table 3-2. The existing stratigraphic database, including information generated during placement of ninety-six monitoring wells at approximately sixty locations sitewide in 1989 and 1990, is adequate to firmly correlate the sequence present beneath the facilities with exposures in Buttermilk Creek Valley, while data acquired more recently, during the 1993 on-site soil boring program, have provided improved resolution on the top of the Lavery till (Wtc in Fig. 3-2) and on the distribution of backfill across the north plateau.

Pre-1993 characterization of the site subsurface comprised a series of six subsurface maps: Plate 2 - Structure: Base of the Lavery Till; Plate 3 - Structure: Top of the Lavery Till; Plate 4 - Thickness: Lavery Till; Plate 5 - Thickness of the Post-Lavery Sequence; Plate 6 - Structure: Top of the Till-Sand; and Plate 7 - Thickness of the Lavery Till above the Till-Sand. This map series was completed in late 1992. Contour intervals of either 5 feet or 10 feet were employed in constructing these maps.

Subsurface data collected during the 1993 on-site soil boring program were used to update the map series.

- |          |   |
|----------|---|
| Plate 2: | Structure: Base of the Lavery Till.<br>No new control generated on this surface in 1993.<br>No changes required.                    |
| Plate 3: | Structure: Top of the Lavery Till.<br>Has been revised to incorporate new data.<br>Contour interval changed from 10 feet to 5 feet. |
| Plate 4: | Thickness: Lavery Till.<br>Minor changes occasioned by changes in Plate 3, but these changes are not pronounced.                    |
| Plate 5: | Thickness: Post-Lavery Sequence<br>Has been revised to incorporate new data.<br>Also revised to conform to Plate 3 as modified.     |
| Plate 6: | Structure: Top of the Till-Sand.  |
| Plate 7: | Thickness of the Lavery Till above the Till-Sand.   |

The top of Devonian bedrock is depicted in Figure 3-3. The availability of bedrock maps in the absence of reliable maps of the older glacial units situated between bedrock and the base of the Lavery till is due in part to the applicability of seismic profiling to resolution of the rock-sediment interface. Also, in reviewing borehole records, the position of bedrock usually can be assigned with confidence, whereas, in many cases, the descriptive material is inadequate to support subdivision of the glacial sequence.

Taken together, these maps describe the distribution and geometry of each of the shallow hydrostratigraphic units at and near the WVDP. As descriptive data products, they require no supporting narrative and are not intended to convey the geologic history of the site.

Plates 2 through 7 are complemented in this document by four structure sections that incorporate the latest data, including those generated in 1993. These sections also complement sections A-A' through G-G' as contained in Part 2 of Environmental Information Document Volume I, Geology (West Valley Nuclear Services Co., Inc. March 14, 1996) as Figures 4-2 through 4-12. The four newly constructed sections and a map depicting their locations are included here as Plates 8 through 12. Stratigraphically, their scope is limited to the upper part of the glacial sequence extending from existing grade downward to and into, but not through, the Lavery till. Accordingly, these sections focus upon and describe that part of the sequence of principal concern in the context of RCRA facilities investigations. Like the maps (Plates 2-7), these sections are mainly descriptive and require little explanatory text.

The WVDP is bounded on the north by Quarry Creek and on the south by Frank's Creek and is divided by Erdman Brook into two areas, the north plateau and the south plateau. The entire WVDP, with the possible exception of limited occurrences in the vicinity of Rock Springs Road, is underlain by up to 30 meters (100 ft) of Lavery till. Glacial units deeper than the Lavery are similarly distributed beneath the entire WVDP as shown on cross sections involving the deeper units (Figs. 2 through 12 in Part 2 of Environmental Information Document, Volume I, Geology [West Valley Nuclear Services Co., Inc. March 14, 1996]).

#### South Plateau

South of Erdman Brook the Lavery till is exposed at grade or is overlain by no more than a veneer of fine-grained alluvium. A surficial weathered zone typically 3 meters (10 ft) thick has developed on the till, and a complex array of fractures, including two or three persistent master sets, characterize the upper few meters of the unit in this setting. The south plateau lies at slightly lower elevations than the north plateau and physiographically is an integral part of the till plain.

Because it is the location for the solid radioactive waste disposal sites, the southern sector of the WVDP has been intensively investigated. The surficial geologic unit in this area is the Lavery till, which, as the host formation for the burial areas, has been thoroughly studied to determine its external and internal geometry, physical and chemical characteristics, engineering properties, and water- and solute-transmitting characteristics. Additionally, the surficial few meters of decomposed and disrupted Lavery have been examined in excavation to further characterize that critical interval of the till. The hydrology of the south plateau is discussed in Environmental Information Document Volume III, Hydrology (West Valley Nuclear Services Co., Inc. March 12, 1996a), and trench studies of the south plateau are included in Part 2 of Environmental Information Document Volume I, Geology (West Valley Nuclear Services Co., Inc. March 14, 1996). The physical, chemical, and engineering characteristics of the Lavery till and, to a lesser extent, those of subjacent units, are presented elsewhere in this report.

An interim summary of the principal characteristics of the Lavery till, based on information contained elsewhere in this volume and in USGS Professional Paper 1325 (Prudic 1986), is as follows:

Unweathered Lavery groundmass is an olive-gray, calcareous, inorganic silty clay to clayey silt of low to medium plasticity consisting mainly of quartz and illite and subordinately of chlorite. It has a dry density of 1.8 g/cc, porosity of 32%, and Atterberg limits indicating a solid with moisture content midway between the plastic limit and the shrinkage limit. The unit is nondispersive (has low erodibility), over-consolidated, and not highly expansive at existing stress levels. There is petrographic evidence to indicate that the till is texturally isotropic.

The base of the till sheet is generally flat to broadly undulose on the scale of the site, and much of the variation in its thickness is due to relief on the top of the unit. Of a nominal 30 meters of Lavery till at the disposal sites, as much as 4.5 meters (15 ft) has been described as fractured, while the calculated maximum depth to which fractures can be maintained is 15 meters (49 ft).

The hydraulic conductivity of the Lavery till is  $2 \times 10^{-8}$  cm/sec to  $6 \times 10^{-8}$  cm/sec, which is lower than that required for recompacted landfill seals. Permeameter and slug-test data alike indicate that the till is essentially isotropic hydraulically, and the calculated effective hydraulic conductivity of a till sequence, including a representative cumulative thickness of water-lain deposits, was found to be essentially the same as the value cited above ( $2 \times 10^{-8}$  cm/sec). Data from clustered piezometers indicate that groundwater moves downward through the till to the underlying permeable lacustrine sequence, and both piezometric data and neutron logging indicate that the upper part of the lacustrine sequence is not saturated and that it functions as a drain for the overlying till. Groundwater moves laterally within the lacustrine sequence to the outcrop along Buttermilk Creek.

#### North Plateau

North of Erdman Brook and eastward to Frank's Creek, the Lavery till is immediately overlain by an alluvial-fluvial complex, up to 12 meters (40 ft) thick, comprising late Wisconsinan water-lain deposits on the east that are partially overlapped from west to east by Holocene alluvium and colluvium. Considering alluvial processes, the fan probably has complex internal geometry, but textural analyses of record have revealed no criteria for discriminating fan and terrace deposits in the subsurface. The Lavery surface was somewhat modified during emplacement of the fan, but otherwise, according to borehole records, is essentially unweathered and unfractured. The areal limits of the north plateau fan-terrace complex, its thickness, and the configuration of its boundary with the Lavery are described in Plate 5 of this document.

In addition to shallow stratigraphic, physiographic, and topographic characteristics, each sector of the WVDP has a distinctive groundwater regime determined mainly by the transmissivity of the uppermost principal geologic unit. The alluvial-fluvial complex beneath the north plateau is recharged by infiltration and by underflow from bedrock, and groundwater flow is generally northward and eastward to the margins of the fan-terrace, where it ultimately discharges at numerous seeps. The underlying Lavery till probably is perennially saturated and an effective aquitard. The hydrogeologic characteristics of the north plateau, including the effects on groundwater flow patterns presented by subgrade structures such as foundations, ditches, and lagoons, are fully discussed in Simulation of Ground-Water Flow near the Nuclear-Fuel Reprocessing Facility (Yager 1987).

Further characterization of the north plateau is afforded by structure sections contained in Geologic and Hydrologic Research (Albanese et al. 1984) depicting north-south (up-valley) variation in bedrock relief near the margin of the till plain and related departures in glacial stratigraphy from the composite idealized section presented by LaFleur. Notable relationships along these transects include relief on bedrock transcurrent to the valley margin of about 12 meters (40 ft), with higher bedrock elevations opposite the north plateau and an indicated swale on the south, opposite the disposal areas.

The presence of thick Holocene alluvium on the north opposite the process building area is obvious and, more significantly, sequences and thicknesses suggest that the alluvium immediately overlies bedrock in some places. Lavery ice advance is thought to have removed most of the older till and recessional deposits in this area. By contrast, the presence on the south, opposite the burial facilities, of limited thicknesses of Kent till and of appreciable thicknesses of Kent recessional strata demonstrates the relationship of topographic settings and the distribution of units; this also indicates the stratigraphic complexity that might be anticipated on the margin of the till plain west of the existing facilities.

### 3.1.2 Regional and Site Structural Geology

The WVDP is located on the glaciated Appalachian Plateau province of western New York. The WVDP facilities are developed on a 1.5-meter to 168-meter (5-550 ft) thick sequence of unconsolidated late Wisconsin glacial deposits that are underlain by approximately 2.30 kilometers (1.4 mi) of Paleozoic sedimentary strata. Regional stresses propagating through these glacial deposits and consolidated strata have produced a variety of geologic structures.

The structural geology of western New York has been studied and described in detail since the early 1900s, with numerous studies completed in the last twenty-five years. These studies have examined major structures such as the Clarendon-Linden Fault Zone, regional fold trends in the Appalachian plateau of western New York, and minor structures such as joints, fractures, and outcrop-scale faults developed in bedrock and till in the immediate vicinity of the WVDP.

#### Regional Bedrock Structures

Overall, the Paleozoic strata of central and western New York dip to the south at approximately  $0.27^\circ$  (7.6 m/km). This regional southward dip is largely the result of isostatic loading of the crust by deposition of 10 kilometers (6.25 mi) of sediment in the Appalachians during the Paleozoic Era and the depression of the crust due to tectonic loading during the Pennsylvanian-Permian Alleghanian orogeny.

Although the overall regional dip is to the south, the Paleozoic-age sedimentary bedrock in the Appalachian plateau of western New York was deformed by northwest-directed compressive stresses that originated during the late Paleozoic Alleghanian orogeny.

#### Regional Scale Folds

Low-amplitude folds with limb dips generally less than  $2^\circ$  were developed in the bedrock of the Appalachian plateau during these orogenic episodes. The axes of these folds trend roughly northeast-southwest in Cattaraugus and Allegany Counties and become more east-west trending to the east in Steuben and Chemung Counties (Wedel 1932).

The regional fold system in central and western New York was produced by regional-scale thrust faults that ramped up-section from the upper Silurian Salina Group to higher stratigraphic intervals in the Paleozoic section. The Bass Islands Trend of southwestern New York is an example of the type of bedrock structure produced during thrust faulting in the Paleozoic bedrock.

The Bass Islands Trend is a narrow northeast-southwest-trending oil- and gas- producing zone extending from southwestern Chautauqua County into northwestern Cattaraugus County (Bastedo and Van Tyne 1990). The Bass Islands Trend may also continue into southern Erie County, but its northern extent is currently unknown due to a lack of subsurface control. The producing zone is structurally controlled and is located at a depth of 792 meters to 884 meters (2,600-2,900 ft) within fractured upper Silurian to middle Devonian sedimentary strata, including the Akron Dolomite, Onondaga limestone, and the Marcellus Shale.

Subsurface mapping suggests the Bass Islands Trend is a low-amplitude anticline that was produced by one or more thrust faults ramping up-section from the upper Silurian Salina Group into Lower Devonian strata. This northeast-trending anticline is one of numerous low-amplitude folds that were developed in the Appalachian plateau of central and western New York during the Late Paleozoic Alleghanian orogeny (Wedel 1932; Engelder and Geiser 1980). These folds follow the arcuate trend of the Appalachian fold belt and are northeast-trending in western New York and east-trending in central New York.

#### Bedrock Fractures

Studies indicate that joints and fractures in bedrock in western New York have a predominantly northwest and northeast orientation (Sun and Mongan 1974; Dana et al. 1979; Engelder and Geiser 1980). The northwest-trending joints parallel the maximum paleo-compression direction that existed during the Late Paleozoic Alleghanian orogeny (Engelder and Geiser 1980). The northeast-trending joints parallel the fold axes of regional-scale folds developed in the Appalachian Plateau of western New York (Engelder and Geiser 1980).

Joints in Upper Devonian rocks in western New York usually terminate at lithologic contacts (Engelder and Geiser 1980). The Upper Devonian Canadaway and Conneaut Groups at the WVDP consist of interbedded shales, siltstones, and massive fine-grained sandstones. The shales and siltstones are generally less than 0.5 meters (1.6 ft) in thickness, while the sandstones may be up to 2 meters (6.6 ft) in thickness.

The small-scale structures observed in bedrock along Cattaraugus Creek are fairly typical of the type of structures formed in bedrock in the Appalachian Plateau of New York. The majority of these structures were produced during the Late Paleozoic Alleghanian orogeny that was responsible for the majority of deformation observed in bedrock in the Appalachian Mountains. The structures observed in local bedrock reflect the strain the bedrock experienced as orogenic stresses propagated through the bedrock.

Strain in the bedrock is manifested as fractures and joints in addition to the previously mentioned faults and regional folds. Northwest- and northeast-trending joint sets have been identified in bedrock in western New York (Sun and Mongan 1974; Dana et al. 1979; Engelder and Geiser 1980).

#### The Clarendon-Linden Fault

The Clarendon-Linden Fault Zone is the only major seismically active fault zone within the area of the WVDP. Earthquakes occurred on this structure in 1929, 1955, 1966, 1967, 1968, 1971, and 1973. The 1929 shock

had a Modified Mercalli Intensity (MMI) of VII and a magnitude of about 5.5; the cluster of shocks recorded between 1955 and 1973 ranged from magnitude 2.7 to magnitude 4.7 (Fletcher and Sykes 1977).

The Clarendon-Linden Fault Zone has been mapped southward from Clarendon, New York on Lake Ontario for approximately 100 kilometers (60 miles) to the Wyoming-Allegany County line near Arcade, New York. The fault zone extends approximately 32 kilometers (20 miles) east of the WVDP. More detailed information concerning this fault is contained in Environmental Information Document Volume 1, Geology (West Valley Nuclear Services Co., Inc. March 14, 1996).

### Structures Developed in Site Soils

Fracture patterns in the glacial till at the WVDP were studied by the New York State Geologic Survey (Dana et al. 1979) and by the WVDP (West Valley Nuclear Services Co., Inc. 1985a).

- New York State Geologic Survey Study

The New York State Geological Survey (NYSGS) studied fractures developed in the Lavery till in three research trenches excavated east and southeast of the SDA (Dana et al. 1979).

The fractures in the Lavery till had a predominant northwest and northeast orientation that correlates with the regional bedrock joint patterns. The calculated maximum depth for open fractures in the Lavery till was 15 meters (49 ft), while the maximum depth at which fractures were observed was 8 meters (26 ft).

The fractures were classified as open, closed, or incipient. Open cracks commonly contained clay films or silt and disrupted material that functioned to prop them open. Closed cracks were revealed by color changes — either brown zones in gray till, indicating passage of oxidizing waters, or gray zones in brown soil, indicating late-stage passage of reducing waters through previously oxidized zones. Incipient cracks were recognized where the till did not display fractures until stressed during excavation.

Five types of fracturing were observed: 1) prismatic and columnar jointing in the "hardpan" soils; 2) long, vertical, parallel joints that traverse the entire altered zone and extend into the parent till; 3) small displacements with and through sand and gravel lenses; 4) horizontal parting attributable to bulldozer scraping; and 5) wall failure and desiccation vertical cracks.

- West Valley Demonstration Project Study

In 1984-1985 the WVDP studied fractures developed in the Lavery till in two research trenches excavated in the NDA (West Valley Nuclear Services Co., Inc. 1985a). The upper 0.5 meters (1.6 ft) of Lavery till were observed to be highly fractured. These fractures were mainly desiccation cracks that were typically polygonal in plan view. Horizontal fractures formed vertical prisms to depths of 0.5 meters (1.6 ft). The desiccation cracking is attributed to wet-dry and freeze-thaw processes.

Two near-vertical fracture sets, a predominant east-trending set, and a subordinate north-northeast-trending set, were observed at depths below 1.7 meters (5.6 ft). The fracture density was observed to decrease with depth. These fracture sets do not correlate with the regional bedrock joint pattern.

Possible mechanisms invoked to explain these fractures include stress release related to movement along the Clarendon-Linden Fault System, post-glacial uplift, or volumetric changes resulting from ion-exchange or isometric processes.

### 3.1.3 Hydrogeology

#### 3.1.3.1 Surficial Sand and Gravel Unit

The north plateau is overlain by up to 12.5 meters (41 ft) of silty sands and gravel that belong to two genetically different clastic sequences. A Pleistocene glaciofluvial gravel overlies the Lavery till and is partly overlain by a younger Holocene alluvial sand and gravel derived from the adjacent hillsides (LaFleur 1979). Textural analysis of the two clastic sequences suggests they are sufficiently similar to be considered as one hydrostratigraphic unit. This unit, the surficial sand and gravel, is classified as an unconfined near-surface water-bearing unit. (Albanese et al. 1983.)

- Hydraulic Properties

- a) Hydraulic Conductivity

The saturated hydraulic conductivity of the sand and gravel unit was estimated from slug tests performed by the USGS (Yager 1987) and by West Valley Nuclear Services (WVNS) on monitoring wells (West Valley Nuclear Services Co., Inc. March 12, 1996a).

The USGS hydraulic conductivity estimates ranged from  $1.2 \times 10^{-4}$  cm/sec to  $9.1 \times 10^{-3}$  cm/sec, with an arithmetic mean of  $1.9 \times 10^{-3}$  cm/sec. In these tests, the Cooper method (Cooper et al. 1967) was used to derive horizontal hydraulic conductivities from the slug test data obtained from eight monitoring wells. Although the Cooper method was originally developed for use in confined conditions with completely penetrating wells, it may be applied to unconfined water-bearing units under some circumstances.

The WVDP conducted rising and falling head slug tests on eighteen wells screened in the surficial sand and gravel layer during 1991-1992 (Table 3-3). The hydraulic conductivities were one order of magnitude lower than those calculated by the USGS (Yager 1987), ranging from  $2.0 \times 10^{-5}$  cm/sec to  $2.6 \times 10^{-3}$  cm/sec, with an arithmetic mean of  $4.2 \times 10^{-4}$  cm/sec (West Valley Nuclear Services Co., Inc. March 12, 1996a). The WVDP hydraulic conductivities were estimated using the Bouwer and Rice method, a method applicable to either completely or partially penetrating wells screened in unconfined water-bearing units (Bouwer and Rice 1976).

- b) Specific Yield

The specific yield ( $S_y$ ) of the sand and gravel ranges from 0.10 to 0.25 (Yager 1987). Lower  $S_y$  values reflect areas of poorly sorted matrices, whereas higher  $S_y$  values indicate areas characterized by well-sorted matrices. A specific yield of 0.22 has been graphically determined for the north plateau sand and gravel using grain-size distributions (Part 3 of the Geology Environmental Information Document Volume 1, Geology, [West Valley Nuclear Services Co., Inc. March 14, 1996]) and the textural classification triangle of Johnson (1967), which relates particle size to specific yield.

### c) Transmissivity

The transmissivity of the sand and gravel unit ranges from  $4.8 \times 10^{-3}$  cm<sup>2</sup>/sec to  $6.8 \times 10^{-3}$  cm<sup>2</sup>/sec (West Valley Nuclear Services Co., Inc. March 12, 1996a). The variability in transmissivity is related to the variable saturated thickness and hydraulic conductivity of the unit.

- Seasonal Groundwater Flow Patterns

Groundwater in the sand and gravel unit generally flows northeastward across the north plateau from the southwestern margin of the unit near Rock Springs Road towards Frank's Creek. (Plate 13.) Groundwater near the northwestern and southeastern margins of the unit diverges from the predominant northeast flow path and flows towards Quarry Creek and Erdman Brook, respectively (Plate 13). Flow is mostly horizontal since the low hydraulic conductivity of the underlying Lavery till precludes any significant downward flow.

The overall hydraulic gradient across the north plateau is 0.031. However, locally steeper and flatter gradients exist in the southwestern and the northeastern portions of the north plateau.

The average groundwater velocity in the sand and gravel unit is 18.6 m/yr (61.0 ft/yr), based on a mean hydraulic conductivity of  $4.2 \times 10^{-4}$  cm/sec, a hydraulic gradient of 0.031, and an effective porosity of 0.22 (West Valley Nuclear Services Co., Inc. March 12, 1996a). A lower velocity of 4.9 m/yr (16.0 ft/year) is estimated in the lagoon area, based on a mean hydraulic conductivity of  $1.3 \times 10^{-4}$  cm/sec, a hydraulic gradient of 0.026, and an effective porosity of 0.22.

Long-term water level trends in the unit suggest a pattern of high water levels from fall through spring and low water levels during the summer (West Valley Nuclear Services Co., Inc. March 12, 1996a). Water levels in the sand and gravel are typically highest in the spring after snow melt and spring precipitation and lowest in summer when evapotranspiration is greatest and the volume of precipitation is relatively low. Well hydrographs indicate that water levels can vary as much as 1.90 meters (6.23 ft) during the year.

The saturated thickness of the sand and gravel ranged from 0.4 to 9.27 meters (1.3 to 30.4 ft) across the north plateau during October 1990. The maximum saturated thickness observed in 1991 occurred during April, ranging from 0.37 to 6.50 meters (1.21 to 21.50 ft). The minimum saturated thickness occurred in July, ranging from 0.10 to 5.91 meters (0.33 to 19.38 ft). The zone of maximum saturation occupies a northeast-trending trough whose long axis coincides with the thickest portion of the sand and gravel unit.

- Recharge and Discharge

- a) Recharge

The USGS estimated a total annual recharge of 66 cm/yr (26 in/yr) to the sand and gravel (Yager 1987).

The WVDP estimated recharge from 1990-1992 seasonal water-level fluctuations and a specific yield of 0.22 (West Valley Nuclear Services Co., Inc. March 12, 1996a). The yearly recharge was estimated to range from 7.7 cm/yr (3.0 in/yr) to 34.2 cm/yr (13.5 in/yr) with mean recharge of 17.3 cm/yr (6.8 in/yr).

The difference in recharge estimates results from the difference in hydraulic conductivities calculated for the sand and gravel. The USGS hydraulic conductivities were an order of magnitude higher than the

WVDP estimates (Yager 1987), resulting in a faster groundwater throughput that required greater recharge to maintain unit saturation.

#### b) Discharge

Groundwater discharges from the sand and gravel to streams, springs, seepage faces, the french drain, the underlying Lavery till, and through evapotranspiration.

The USGS estimated a groundwater discharge rate of 59 cm/yr (23 in/yr) from the sand and gravel. The greatest discharge, totaling approximately 21 cm/yr (8.3 in/yr), was estimated to occur from springs and seeps along the periphery of the north plateau. Discharge from the springs and seeps may have been underestimated since discharge could not be measured from all of the seeps around the north plateau (Yager 1987). Approximately 18 cm/yr (7.1 in/yr) was attributed to evapotranspiration. Vertical leakage to the underlying Lavery till was considered negligible, as only 1 cm/yr (0.4 in/yr) was estimated to be discharged to the Lavery till.

- Topographic and Manmade Features Influencing Groundwater Flow

The groundwater flow path in the sand and gravel unit is largely controlled by topography, flowing to the northeast from higher elevations at Rock Springs Road towards lower elevations in the stream valleys of Erdman Brook, Frank's Creek, and Lagoon Road Creek (Plate 13).

The high-level waste tank farm (HLWTF), the process building, and a french drain influence local groundwater flow in the sand and gravel unit. The HLWTF and portions of the process building were excavated through the sand and gravel unit into the underlying Lavery till. The excavations may have been backfilled with material less permeable than the surrounding sand and gravel, thereby impeding groundwater flow in the area (Yager 1987). Groundwater is periodically pumped from a gravel layer underlying the waste tanks to maintain a groundwater elevation of 424.0 to 424.7 meters (1,391 to 1,393 ft) above mean sea level (MSL).

The french drain is a 15-centimeter (6-in) diameter perforated pipe that is located 3.0 meters (9.8 ft) below the ground surface along the northwest boundary of lagoons 2 and 3 and the northeast boundary of lagoon 3. The french drain was installed to prevent groundwater infiltration into lagoons 2 and 3; it drains portions of the sand and gravel and discharges the intercepted groundwater into Erdman Brook via SPDES outfall 008, opposite the northeastern edge of lagoon 3.

#### 3.1.3.2 Weathered Lavery Till

Weathered Lavery till is best developed on the south plateau, where it ranges up to 4.6 meters (15 ft) in thickness. On the north plateau, where it is buried beneath up to 12.2 meters (40 ft) of post-Lavery deposits, its nominal thickness is less than 0.30 meters (1 ft).

- Hydraulic Properties

##### a) Hydraulic Conductivity

The saturated hydraulic conductivity of the weathered Lavery till was estimated by the USGS (Prudic 1982 and 1986; Bergeron et al. 1987) and WVNS (Dames & Moore 1983a and 1983b) by in-situ testing of

piezometers and wells screened in the weathered Lavery till and by laboratory permeameter and consolidation testing of the weathered Lavery till.

In-situ bail tests performed on three piezometers screened within the weathered, fractured till (Prudic 1982) yielded hydraulic conductivities that ranged from  $2.0 \times 10^{-8}$  cm/sec to  $6.0 \times 10^{-6}$  cm/sec. The Hvorslev method (Hvorslev 1951) was used to estimate hydraulic conductivity from the bail test data. The Hvorslev method is particularly well-suited for piezometers with short screens.

The hydraulic conductivity of unfractured weathered Lavery till ranged from  $2.0 \times 10^{-8}$  cm/sec to  $2.0 \times 10^{-7}$  cm/sec, which is similar to the unweathered Lavery till. A hydraulic conductivity of  $6.0 \times 10^{-6}$  cm/sec was measured for fractured weathered Lavery till.

The vertical hydraulic conductivity ( $K_v$ ) of the weathered Lavery till was estimated by constant-head permeameter testing and ranged from  $2.5 \times 10^{-8}$  cm/sec to  $1.2 \times 10^{-7}$  cm/sec and averaged  $4.9 \times 10^{-8}$  cm/sec (Bergeron et al. 1987).

- Seasonal Groundwater Flow Patterns

Groundwater in the weathered till generally flows north-northeast across the south plateau under a hydraulic gradient of 0.02 towards the stream valleys of Frank's Creek, Erdman Brook, and Lagoon Road Creek (Plate 14) (West Valley Nuclear Services Co., Inc. 1985a; Prudic 1986; Bergeron et al. 1987). Prudic (1982) calculated an average groundwater flow velocity of 1.3 m/yr (4.4 ft/yr) for the weathered Lavery till using a hydraulic conductivity of  $4.0 \times 10^{-5}$  cm/sec, a hydraulic gradient of 0.02, and an effective porosity of 0.19.

A similar flow velocity of 1.4 m/yr (4.5 ft/yr) was calculated from the estimated thirteen years that it took for radioactively contaminated n-dodecane and tributyl phosphate to migrate 18 meters (59 ft) from several special burial holes in the NDA to monitoring well 82-5A on the north side of the NDA (West Valley Nuclear Services Co., Inc. March 12, 1996a).

Water level elevations in the weathered Lavery till in the south plateau show large fluctuations that may vary up to 4.6 meters (15 ft) in individual wells. The largest fluctuations are seen in the wells located in the SDA. These large fluctuations are primarily due to the extremely low water levels observed during the summer of 1991.

- Recharge and Discharge

- a) Recharge

The USGS proposed recharge rates of 1.4 cm/yr (0.6 in/yr) to 3.8 cm/yr (1.5 in/yr) for its computer simulations, which evaluated groundwater flow in the weathered till near the NDA and SDA (Bergeron and Bugliosi 1988). The WVDP estimated a recharge rate of 7.4 cm/yr (2.9 in/yr) to the weathered till from its modeling of watershed runoff (West Valley Nuclear Services Co., Inc. March 12, 1996a).

- b) Discharge

A portion of groundwater within the weathered till discharges to the local marshes and stream valleys that border the burial areas around the south plateau. Discharge within these areas, calculated using computer

simulations performed by Bergeron and Bugliosi (1988), amounted to  $1.5 \times 10^{-4}$  m/day ( $4.9 \times 10^{-4}$  ft/day). During summer, the discharge areas remained saturated even though the streams were not flowing, indicating groundwater seepage (Bergeron and Bugliosi 1988).

- Topographic and Manmade Features Affecting Groundwater Flow

Groundwater flow in undisturbed weathered till in the south plateau is largely controlled by topography, flowing northeast from higher elevations at Rock Springs Road towards lower elevations in the stream valleys of Erdman Brook, Frank's Creek, and Lagoon Road Creek (Plate 14). Since groundwater flow is also controlled by a network of interconnecting fractures, the northeast flow path may be temporarily disrupted in the NDA and SDA, which have been extensively excavated and graded during their operation as waste disposal areas.

The NDA interceptor trench was installed along the northwest and northeast sides of the NDA in 1989-1990 to intercept any waste that may migrate from the burial holes through the weathered Lavery till. The trench is 274 meters (975 ft) long, 1.22 meters (4.0 ft) wide, and 3.66 meters to 6.40 meters (12 ft to 21 ft) deep, extending a minimum of 0.30 meters (1 ft) below the weathered/unweathered till interface. The NDA interceptor trench acts as a sink for groundwater in the weathered Lavery till. (See Plate 14.)

In 1992 a 271-meter (890-ft) long and 9-meter (30-ft) deep slurry wall was installed along the southwest side of the SDA to prevent the infiltration of weathered till groundwater into SDA burial trench 14. The slurry wall is composed of a till-bentonite slurry that has an estimated hydraulic conductivity of  $1 \times 10^{-7}$  cm/sec or less. (Dames & Moore July 23, 1993.) Groundwater intercepted by the wall may slowly migrate to the north and south along the outside of the wall and discharge into Frank's Creek or Lagoon Creek Road. (See Plate 14.)

### 3.1.3.3 Unweathered Lavery Till

The unweathered Lavery till ranges up to 36.6 meters (120 ft) in thickness; its upper surface lies at elevations ranging from 387 meters (1,270 ft) NGVD at the confluence of Frank's and Quarry Creeks to about 442 meters (1,450 ft) NGVD in the vicinity of Rock Springs Road. On the north plateau the till is overlain by up to 12.2 meters (40 ft) of post-Lavery deposits; on the south plateau it is the surficial geologic unit.

The Lavery is a gray to greenish gray slightly pebbly silty clay or clayey silt. In geotechnical terms, the till is very stiff to hard. The unit has a low overall hydraulic conductivity and functions as an aquitard.

- Hydraulic Properties

- a) Hydraulic Conductivity

The USGS estimated the horizontal hydraulic conductivity of the unweathered Lavery till from bail tests performed on twelve piezometers installed in this unit (Prudic 1982). The Cooper method (Cooper et al. 1967) and the Hvorslev method (Hvorslev 1951) were used to estimate hydraulic conductivity from the bail test data. The horizontal hydraulic conductivity determined by the Cooper method ranged from  $2.0 \times 10^{-8}$  cm/sec to  $1.0 \times 10^{-7}$  cm/sec and averaged  $6.0 \times 10^{-8}$  cm/sec, while the Hvorslev method ranged from  $1.0 \times 10^{-8}$  cm/sec to  $3.0 \times 10^{-8}$  cm/sec and averaged  $2.0 \times 10^{-8}$  cm/sec.

The vertical hydraulic conductivity ( $K_v$ ) and horizontal ( $K_h$ ) hydraulic conductivity of the unweathered Lavery till was also estimated from laboratory falling-head permeameter testing (Prudic 1982; Dames & Moore 1983a; Dames & Moore 1983b). The  $K_v$  for the Lavery till ranged from  $1.1 \times 10^{-8}$  cm/sec to  $1.5 \times 10^{-7}$  cm/sec and averaged  $6.2 \times 10^{-8}$  cm/sec. The  $K_h$  ranged from  $2.1 \times 10^{-8}$  cm/sec to  $9.6 \times 10^{-8}$  cm/sec and averaged  $3.8 \times 10^{-8}$  cm/sec. These results suggest that the hydraulic conductivity of the Lavery till is essentially isotropic.

Falling-head permeameter and constant-head permeameter testing performed at successively increasing confining pressures suggests that the  $K_v$  of the unweathered Lavery till decreases with increasing depth of burial and averages  $1.6 \times 10^{-8}$  cm/sec (Prudic 1982; Bergeron et al. 1987). The  $K_v$  of samples tested at atmospheric pressure was nearly three times greater than the  $K_v$  of samples tested at confining pressures representative of their original depth of burial.

The hydraulic conductivity of the silt and fine-sand layers within the Lavery till ranged from  $2.0 \times 10^{-7}$  cm/sec to  $2.0 \times 10^{-5}$  cm/sec.

#### b) Specific Storage

The USGS calculated storage properties of the unweathered Lavery till from consolidation tests performed on samples collected near the SDA from depths of 6 to 16 meters (20 to 53 ft) (Prudic 1986). The specific storage decreased with depth from a maximum of  $1.6 \times 10^{-5}$  /cm ( $6.3 \times 10^{-6}$  /in) at a depth of 5.8 meters (19 ft) to a minimum of  $2.0 \times 10^{-6}$  /cm ( $7.9 \times 10^{-7}$  /in) at a depth of 16 meters (52 ft). The average specific storage across this interval was  $8.0 \times 10^{-6}$  /cm ( $3.15 \times 10^{-6}$  /in).

#### • Seasonal Groundwater Flow Patterns

Groundwater in the unweathered Lavery till generally flows vertically downward towards the underlying Kent recessional sequence (West Valley Nuclear Services Co., Inc. 1985a; Prudic 1986; Bergeron et al. 1987). A downward hydraulic gradient ranging from 0.95 to 1.09 and averaging 1.033 was estimated from April 1985 data collected from piezometer clusters in and around the NDA and SDA (West Valley Nuclear Services Co., Inc. 1985a). These downward gradients also predominate near adjoining stream valleys (Prudic 1986).

Groundwater in the unweathered till is estimated to flow at an average linear flow velocity of 0.06 m/yr (0.2 ft/yr), based on a mean hydraulic conductivity of  $3.2 \times 10^{-8}$  cm/sec, a mean hydraulic gradient of 1.033, and an effective porosity of 0.17 (West Valley Nuclear Services Co., Inc. 1985a).

Piezometers screened at shallow depths show significant seasonal variations in water levels, whereas those installed at deeper levels show little to no variation in water level throughout the year. Not all of the piezometers installed in the unweathered till contain water, suggesting that the unit is under tension-saturated conditions in places where high capillary tension precludes migration of water into the piezometer.

#### 3.1.3.4 Lavery Till-Sand

The Lavery till-sand is an intra-till unit comprising a water-lain stratified association of gravels, sands, silts, and clays. As defined presently, it underlies a relatively limited area of the north plateau, as shown on Plate 6, and is overlain by clay-silt till to thicknesses shown in Plate 7. The distribution of this unit, as shown, should be considered as provisional pending the generation of additional subsurface data.

- Hydraulic Properties

- a) Hydraulic Conductivity

A hydraulic conductivity of  $1.3 \times 10^{-4}$  cm/sec was calculated for the Lavery till-sand from a slug test performed on a single well screened in this unit (West Valley Nuclear Services Co., Inc. March 12, 1996a). Analyses of particle-size data on the Lavery till-sand, conducted by Dames & Moore, yielded an average hydraulic conductivity of  $6.2 \times 10^{-5}$  cm/sec. These hydraulic conductivities are more than two orders of magnitude greater than those calculated for the surrounding clay-silt till.

- Seasonal Groundwater Flow Patterns

Water level elevations in the Lavery till-sand are above the top of the unit, indicating that both saturated and artesian conditions exist. Groundwater elevations are approximately 1.5 to 2.1 meters (5 to 7 ft) above the top of the till-sand southwest of the process building and are 2.1 to 6.1 meters (7 to 20 ft) above the top of the till-sand in the area beneath the sludge ponds and equalization basin.

The potentiometric surface of the Lavery till-sand slopes to the southeast towards Erdman Brook. Groundwater elevation fluctuations have generally varied less than 1.8 meters (6 ft) since the wells have been monitored.

- Recharge and Discharge

No discharge zones have been observed in the field. Discharge occurs as percolation to the underlying Lavery till. Recharge occurs as leakage from the overlying Lavery till and from the sand and gravel water-bearing unit, where the overlying Lavery till layer is not present.

### 3.1.3.5 Kent Recessional Sequence

Beneath most of the WVDP and immediately underlying the Lavery till is the Kent recessional sequence. This hydrostratigraphic unit is an association of interstadial gravel, sand, silt, and clay. This unit constitutes a relatively transmissive segment of the overall pathway from the WVDP to Buttermilk Creek for such groundwater as might traverse the entire section of the Lavery (clay-silt) till.

- Hydraulic Properties

- a) Hydraulic Conductivity

Based on slug test data, the hydraulic conductivity of the unit is estimated to range from  $5.5 \times 10^{-7}$  cm/sec to  $1.5 \times 10^{-6}$  cm/sec (West Valley Nuclear Services Co., Inc. March 12, 1996a). Particle-size analysis suggests a hydraulic conductivity of  $8.4 \times 10^{-6}$  cm/sec for the lacustrine sediments and  $8.4 \times 10^{-5}$  cm/sec for the coarser clastics. The USGS estimated a higher hydraulic conductivity of  $1 \times 10^{-4}$  cm/sec from grain size distribution data (Prudic 1986).

- Seasonal Groundwater Flow Patterns

Water levels from piezometers screened at the base of the sequence suggest a northeast hydraulic gradient of 0.023 (Bergeron et al. 1987). Although interbedded till is locally present in the sequence, water-level data suggest that the entire sequence behaves as a single hydrostratigraphic unit.

A vertical downward gradient towards the underlying till may also be present, but the rate of downward flow through the layered lacustrine deposits is probably much slower than the rate of lateral flow.

The upper parts of the Kent recessional sequence beneath the south plateau are unsaturated (Prudic 1986); however, the deeper lacustrine deposits are saturated and may provide an avenue for slow northeast lateral flow to points of discharge in the bluffs along Buttermilk Creek. The unsaturated conditions in the upper sequence are the result of very low vertical permeability in the overlying till, and thus there is a low recharge through the till rather than high horizontal permeability in the Kent recessional sequence. Nevertheless, the recessional sequence acts as a drain to the till and causes downward gradients in the till of 0.7 to 1.0.

The WVDP estimated an average linear velocity of 13.1 cm/yr (0.4 ft/yr) from a hydraulic conductivity of  $4.5 \times 10^{-6}$  cm/sec (the average of field and laboratory data), a hydraulic gradient of 0.023 (Bergeron et al. 1987), and a porosity of 0.25. The USGS estimated an average linear velocity of 1.7 m/yr (5.5 ft/yr), based on a hydraulic conductivity of  $1 \times 10^{-4}$  cm/sec, a hydraulic gradient of 0.013, and a porosity of 0.25 (Prudic and Randall 1977). The higher velocity results from the USGS-derived hydraulic conductivity of  $1 \times 10^{-4}$  cm/sec, which is faster than that derived by the WVDP.

- Recharge and Discharge

Recharge to the Kent recessional sequence comes from both the overlying till and the adjacent bedrock valley wall. Discharge occurs at bluffs along Buttermilk Creek and to the underlying till. It is this pattern of recharge and discharge, combined with the fact that the upper portion of the Kent recessional sequence is unsaturated, that has led to the hypothesis that this unit functions as a drain for the overlying Lavery till.

### 3.1.3.6 Bedrock

The bedrock surface underlying the site occurs as a U-shaped buried valley filled with as much as 152 meters (500 ft) of Pleistocene-age glacial deposits. Outcrops are limited to the areas along the upper reaches of Quarry Creek and sparsely vegetated hilltops west of the site. The lithologic units in the vicinity of the site consist of upper Devonian shales and siltstones of the Conneaut and Canadaway Groups (Rickard 1975). Bedding in these units regionally dips approximately 0.5 degrees southward. Vertical joint sets, approximately 30 centimeters (12 in) in length and 60 centimeters (24 in) apart, trend N68°E and N45°W (Sun and Mongan 1974).

- Hydraulic Properties

Regional groundwater in the bedrock tends to flow downward within the higher hills, laterally beneath lower hillsides and terraces, and upward near major streams. Downward flow within the higher hills is evidenced by lower water levels in deeper wells. Upward flow near major streams is evidenced by flowing wells, which indicate an upward hydraulic head gradient. Regional flow patterns are also evidenced by the distribution of groundwater that contains chloride concentrations above the 2 to 25 mg/L typical of shallow wells in this

region. Chloride concentrations of several hundred mg/L or more are universal in the shales and siltstones of this region beneath the zone of fresh water. Depth to high-chloride water usually is much less beneath the valley floors than beneath the hills. The occurrence of high chloride concentrations in wells suggests that water comes from the deeper, more regional flow system. However, local well data suggests that the reach of Buttermilk Creek adjacent to the SDA is not a discharge point for a regional flow system (Prudic 1986).

None of the wells drilled into the weathered bedrock are artesian and production is low. Transmissivities within the weathered zone have been estimated at 3 L/day (Nuclear Fuel Services, Inc. 1973). Little data exists on the deeper bedrock; however, gas wells in the area have encountered brine at depth. The chemical quality of groundwater from the bedrock indicates that calcium and bicarbonate are the major chemical constituents. (This potable water is tapped by the majority of domestic wells in the area.)

#### a) Hydraulic Conductivity

The upper 3 meters (10 ft) of bedrock, on the average, has been both mechanically and chemically weathered and contains abundant fractures and decomposed rock, which makes this layer more hydraulically transmissive than the underlying competent bedrock. Hydraulic conductivity in the weathered zone has been estimated at  $10^{-5}$  cm/sec, with corresponding well yields in the range of 40 to 60 L/min (10.6-15.9 gal/min). The hydraulic conductivity of the underlying competent rock has been estimated at  $10^{-7}$  cm/sec (Prudic 1986). The difference in conductivities between these two zones suggests preferential flow through the weathered portion, which would be directed downslope within the weathered zone towards the axis of the buried valley.

### 3.2 Soil Characteristics

#### 3.2.1 Soil Conservation Service Classification

Cattaraugus County does not have a published general soil map, but preliminary maps of the site area obtained from the Soil Conservation Service (SCS) in Ellicottville, New York, indicate that the north and south plateaus are underlain by the Churchville silt-loam. This preliminary information, while potentially accurate for the south plateau and other site sectors immediately underlain by glacial till, is incorrect for those site sectors, such as the north plateau, that are mantled by alluvium or high-energy fluvial deposits. Soil types generally correspond to near-surface unconsolidated glacial deposits altered by natural chemical weathering and biological activity. However, construction and maintenance activities at the WVDP have altered much of the original distribution of soil horizons and types.

Descriptions of soil series associated with and developed upon alluvial and fluvial deposits in southernmost Erie County in the vicinity of the WNYNSC were evaluated to identify the unit that conforms most closely to the north plateau soils. The operative criteria for identifying the soils that most closely conform to the north plateau soils are landform type and position, parent material, and mode of deposition.

From among the soils mapped in southern Erie County, the most likely candidates for extrapolation to the alluvial/fluvial complex on the north plateau are the Chenango series and the Middlebury series. The Chenango consists of deep, well-drained to somewhat excessively drained soils on outwash plains and associated moraines, terraces, deltas, remnant beaches, and alluvial fans. These soils formed on well-sorted deposits. Slope ranges from 0% to 50% but is predominantly 0% to 8%.

The Chenango soil that best applies in the present context is the Chenango channery silt-loam. This unit develops on 0% to 3% slopes and on 3% to 8% slopes; in both settings the soil is deep and well-drained. It typically develops on alluvial fans. Its occurrences are most commonly triangular or fan-shaped and are 2 to 12 hectares (5 to 30 acres) in extent. The following description of the channery silt-loam (0% to 3% slopes) is an excerpt from the Soil Survey of Erie County, New York (U.S. Department of Agriculture December 1986):

"Typically, this soil has a surface layer of dark brown channery silt loam about 8 inches thick. The subsoil extends to a depth of about 32 inches. It is yellowish brown channery loam in the upper part and dark brown very channery loam in the lower part. The substratum is dark brown and light brownish gray very gravelly loamy sand to depths of 60 inches or more . . . The permeability of this soil is moderate to moderately rapid in the subsoil and rapid in the substratum. The available water capacity is low to moderate, and runoff is slow to medium. Channery fragments make up 15 to 30 percent of the surface layer. In unlimed areas, the surface layer is strongly acid or very strongly acid and the subsoil is very strongly acid to medium acid."

Chenango gravelly loams are the dominant soil types in the Springville area above 396 meters (1,300 ft) NGVD. However, the association of landforms north of Cattaraugus Creek within the southward-directed drainage patterns north of the Cattaraugus does not include high-level alluvial fans such as those that overlie the Lavery till plain in Buttermilk and Connoissarauly valleys. Nonetheless, Chenango soils conform quite well to the Holocene alluvium at the site on the basis of texture and according to the criteria listed above.

Middlebury soils, specifically the Middlebury silt-loam, occur mainly adjacent to Cattaraugus Creek as a component of floodplain soil associations and, therefore, are not entirely analogous to the landforms at the process building site. In its other aspects, however, the Middlebury series fits the description of the alluvial/fluvial sequence at the site as indicated in the following excerpt from the Soil Survey of Erie County, New York.

"The Middlebury series consists of deep, moderately well drained to somewhat poorly drained soils on nearly level flood plains and on a few alluvial fans. These soils formed in alluvial deposits derived from upland soils having a high component of shale and sandstone. Slope ranges from 0 to 3 percent."

Soils similar to either of the above underlie the north plateau and extend to the limit of alluvial cover on the Lavery till.

The south plateau at the WVDP is underlain by the Churchville silt-loam. The Churchville occurs on slopes of 3% to 8% along the shoulder of the valley to the west of the site and also has developed on the nearly level till plain (0% to 3% slopes) farther out on the south plateau. The following description of the Churchville is taken from the Soil Survey of Erie County, New York.

CoA - Churchville silt loam 0 to 3 percent slopes - This nearly level soil is deep and somewhat poorly drained. It formed in a thin mantle of clayey lake sediments underlain by glacial till. This soil is on broad flats of the lowland till plain. Areas of this soil are oblong or irregular in shape and range from 10 to 200 acres.

Typically, this soil has a surface layer of very dark grayish brown silt loam about 9 inches thick. The subsurface layer is mottled, pinkish gray silt loam about 2 inches thick. The subsoil is 15 inches thick. The upper part of the subsoil is reddish brown silty clay loam, and the lower part is firm, mottled, reddish

brown silty clay. The substratum is very firm, mottled, reddish gray gravelly loam to a depth of 60 inches or more.

This Churchville soil has a perched seasonal high water table in the upper part of the subsoil from December through May and is susceptible to ponding in some areas. Rooting depth is limited by the seasonal high water table. Permeability is slow or very slow in the subsoil or substratum. The available water capacity is moderate to high, and runoff is slow. Bedrock is at a depth of 5 feet or more. The surface layer is medium acid to neutral, and the subsoil is slightly acid to mildly alkaline.

Inspection of the old and recent topographic maps, historical imagery, and borehole logs indicate that little soil, as defined pedologically, remains in place over much of the site. Rather, the shallowest material commonly is either fill or recompactd till obtained from local borrow sources or in-place weathered parent till lacking the soil profile described above.

### 3.2.2 Unified Soil Classification System

The vast majority of the alluvium sampled on and in the vicinity of the WVDP has been classified as GM or SM in the Unified Soil Classification System (USCS) (Fig. 3-4). These are well-graded silty gravels and silty sands. USCS descriptions are entered on all borehole logs on file with Dames & Moore.

Most of the till samples taken on and in the vicinity of the WVDP have been classified as CL or ML. These are inorganic clays, silts, clayey silts, and silty clays of low plasticity. Logs of the 1982 and 1983 series of boreholes drilled by the USGS at the NDA, and logs of the 1985 and 1980-1990 series of boreholes drilled by Dames & Moore indicate that the Lavery is lithologically uniform throughout its extent at the WVDP.

The Kent till underlies the Lavery at the WVDP and typically is stratigraphically separated from the Lavery by nontill deposits. The Kent till is essentially the same as the Lavery texturally, according to a very limited number of analyses (Albanese et al. 1983). The interstadial sequence that immediately underlies the Lavery till is an association of relatively permeable deposits, silts and clays, and sands and gravels (Prudic 1986); patterns of lateral variation are not well established. In any event, the sequence as a whole is more permeable than the underlying and overlying till sheets by at least two orders of magnitude.

### 3.2.3 Geomechanical Characteristics

Shallow geologic units at the WVDP have been defined in terms of their static and dynamic geomechanical properties. These properties are significant in determining response to seismic shock, capacity to attenuate environmental contaminants, and hydraulic transmissivity.

#### 3.2.3.1 Particle Size Distribution

The particle-size data reflect the pronounced uniformity of the Lavery till. Based on these data, the till is a gravelly mud. The alluvial deposits, in terms of their grain-size characteristics, are muddy gravels and muddy sandy gravels. The nominal dry density of the alluvium is markedly greater than that of the till, and the alluvium, predictably, possesses high angles of internal friction.

Particle-size analyses were first performed at the WVDP by Albanese et al. (1983). Albanese classified the Lavery till data into three groups to represent LaFleur's (1979) facies interpretation and developed nontill

interbeds into three classes. Albanese also analyzed three samples of Kent till. The Albanese data are summarized in Figures 3-5 and 3-6.

Particle-size analyses were also performed by Dames & Moore on representative samples of site soils in accordance with American Society for Testing and Materials (ASTM) D-422-63. The data have been summarized in particle-size distribution triangles and accompanying maps showing the borehole locations. The distribution triangles and associated maps are provided in Environmental Information Document Volume I, Geology. (West Valley Nuclear Services Co., Inc. March 14, 1996).

The data reveal the pronounced textural uniformity of the Lavery till and that the till is characteristically a gravelly mud (gM) and the alluvial and fluvial deposits on and near the process building site are muddy gravels (mG) and muddy sandy gravels (msG).

A ternary plot of grain-size data from the USGS 1980 series of shallow boreholes on the north plateau and data from samples taken in the 1989-1990 drilling program are included in Environmental Information Document, Volume I, Geology (West Valley Nuclear Services Co., Inc. March 14, 1996). As described by the ternary plots, the samples are muddy gravels (mG), muddy sandy gravels (msG), and gravelly muddy sands (gmS) (Folk 1974).

Significant percentages of all the grain-size classes are represented. The Lavery till is very poorly sorted. On a field scale, the sorting of the till is poorer still in that clasts larger than the diameter of the sampling device are common within the till.

Ternary plots indicating the textural composition of the Lavery till, including twenty-four analyses representing five boreholes and a depth range of 22 meters (72 ft), and sixteen analyses representing ten boreholes and a depth range of 15 meters (49 ft), characterize the Lavery as a gravelly mud containing, on the west, average percentages by weight of 17% gravel, 16% sand, 32% silt, and 35% clay. On the east, the weight percentages are 10% gravel, 13% sand, 27% silt, and 50% clay. The Environmental Information Document Volume I, Geology contains the ternary plots supporting these results (West Valley Nuclear Services Co., Inc. March 14, 1996).

Textural characterization of the interstadial sequence might reasonably be inferred from analyses of nontill lithologies contained within the Lavery till. For the most part, these masses were torn from the substrate immediately north of the WVDP and incorporated in the burial till. Textural analyses of eleven samples taken from depths of 4 to 11 meters (13-38 ft) within the Lavery have been summarized by Prudic (1986). The ranges for the grain-size classes (gravel: 0%-71%; sand: 0%-49%; silt: 8%-78%; and clay: 5%-70%) reflect the lithologic diversity of the sub-Lavery sequence. Employing the same classification as before, these rip-ups (and the parent strata) comprise muddy gravels, gravelly muds, and slightly gravelly muds and sandy muds.

Clearly, these lithologies represent the most cohesive elements of the interstadial sequence and probably should not be construed as a complete characterization of that sequence.

### 3.2.3.2 Atterberg Limits

Atterberg limits normally are not determined for granular soils and are not available for the sand and gravel.

The plasticity of the Lavery till, expressed as Atterberg limits, is mainly consistent with field descriptions entered on borehole logs — inorganic mixtures of rock flour, clay, silt, and very fine sand of low to medium plasticity.

Soil samples were tested to evaluate their Atterberg limits — liquid limit, plastic limit, and plasticity index — in accordance with ASTM D-4318-84. The results of these tests were used primarily for purposes of classification and correlation.

Most of the tests resulted in a classification of CL — inorganic clays of low to medium plasticity. Of the remaining tests, most resulted in classifications of CL-ML or ML, indicating somewhat siltier materials.

These classifications are consistent with determinations made visually in the field and entered on the field logs. For many of the samples, proportions of coarser grain-size classes, that is, sand and gravel, were determined by particle-size analyses.

### 3.2.3.3 Bulk Density and Moisture Content

Dry density and moisture content have been determined for samples taken from boreholes, trenches, and test pits in accordance with method ASTM D-2216.

Based on the vertical distribution and dry density of samples of the alluvium on the north plateau, a mean density value of 1.90 g/cm<sup>3</sup> is characteristic of the alluvium and is an important factor in determining the retardation factors for contaminants in groundwater. The natural moisture content of the samples ranges from 8% to 34% and averages 14%.

A mean value of 1.86 +/- 0.16 g/cm<sup>3</sup> is considered characteristic of the dry density of the burial till located south of Erdman Brook in the vicinity of the NDA. Documentation supporting these values can be found in the Environmental Information Document Volume I, Geology (West Valley Nuclear Fuel Services., Inc. March 14, 1996).

### 3.2.3.4 Specific Gravity

Tests to determine the specific gravity of solids were performed on samples in accordance with ASTM D-854. The values obtained ranged from 2.65 to 2.75 and averaged 2.71; these are characteristic of alumino-silicate assemblages.

### 3.2.3.5 Strength

The relative density of the cohesionless alluvial soil on the north plateau was evaluated by means of standard penetration tests. The test values ranged from 7 to refusal, with most values falling between 20 and 60. Based on the correlation between relative density and standard penetration resistance developed by Gibbs and Holtz (1957), the relative density for the upper layer of gravelly soil ranges from 45% to 90% and

typically exceeds 70%. For the lower layer of gravelly soil the relative density is on the order of 90% or more. The material therefore can be considered stiff to hard, with occasional medium-stiff layers.

The relative density of the Lavery till has been evaluated by means of standard penetration tests. Blow count data from wells installed within and near the NDA in 1984 and 1985 were plotted against elevation. The test values ranged from 5 to refusal, with most values falling between 10 and 40. Below elevation 418 meters (1,370 ft) NVGD, the number of blow counts tends to increase slightly with increasing depth. No trend is apparent above 418 meters (1,370 ft) NGVD, where data points represent blow counts for both weathered and unweathered till. When the wells are considered individually, the blow counts in most instances peak midway between the ground surface and the weathered/unweathered till contact. This would support a higher value of undrained shear strength for the weathered than the unweathered till. The extreme N-values near the base of the section reflect the presence of dense sub-Lavery sands.

### 3.2.4 Geochemical Characteristics

Site and site-area soils have been described in terms of their elemental composition, oxides of major elements, mineralogy, soil pH, cation exchange capacity, inherent radioactivity, and fraction organic content of the glacial tills. Most of these determinations apply to the Lavery till; there is much less geochemical information available to characterize the surficial sand and gravel unit on the north plateau.

#### Surficial Sand and Gravel Layer

- Soil Chemistry

X-ray diffraction was performed on five surficial sand and gravel cores collected during the 1989-1990 monitoring well installation program. Illite is clearly the dominant clay mineral, with kaolinite second and chlorite third. Minerals present in the less-than-75-micron fraction of all six samples include quartz, muscovite, chlorite, plagioclase, and chlinochlor. Two of the samples exhibited minor peaks for dolomite and calcite.

Exchangeable base cation analyses (or exchangeable bases) measure the exchangeability of  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{2+}$ , and  $\text{Mg}^{2+}$ . This analysis was performed on five surficial sand and gravel soil cores collected during the 1989-1990 monitoring well installation program. Results indicate a moderate to high exchangeability for the four cations, with  $\text{Ca}^{2+}$  being especially high. It is important to note that the very high concentrations of  $\text{Ca}^{2+}$  are most likely the result of dissolution of calcite ( $\text{CaCO}_3$ ) and not desorbed  $\text{Ca}^{2+}$  from the exchange process.

The distribution coefficient ( $K_d$ ) can be used to assess the degree to which a chemical species will be removed from solution as it passes through a geologic medium and, in turn, provides indication of how rapidly an ion can move relative to the rate of groundwater movement. Adsorption kinetics and corresponding  $K_d$ 's were determined for  $\text{Cs}^{137}$  and  $\text{Sr}^{85}$ . ( $\text{Sr}^{85}$  was substituted for  $\text{Sr}^{90}$  because of its greater safety factor for handling and its similar behavior.) Two samples were analyzed by the batch method (ASTM D4319-83) and yielded  $K_d$ 's of 150 mL/g and 140 mL/g for  $\text{Cs}^{137}$  and 15.2 mL/g and 14.3 mL/g for  $\text{Sr}^{85}$ . These data indicate a relatively high adsorptive capacity for  $\text{Cs}^{137}$  and therefore a low mobility, as compared to  $\text{Sr}^{90}$ .

## Weathered Lavery Till

- Soil Chemistry

Exchangeable base cations on five samples of weathered till collected during the 1989-1990 monitoring well installation program were measured by Brookhaven National Laboratory. The results indicate a relatively high exchange capacity for  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$ , a moderate exchange capacity for  $\text{K}^{+}$ , and a relatively low exchange capacity for  $\text{Na}^{+}$ . The exchangeability of  $\text{Ca}^{2+}$  was very high and may be attributed to the dissolution of calcite ( $\text{CaCO}_3$ ) and not desorption of  $\text{Ca}^{2+}$  from the exchange process; thus, the total meq of cations exchanged ( $\text{M}^{+}$ ) should be considered both with and without  $\text{Ca}^{2+}$ . Percent organic matter measured on two samples of weathered till were 1.54% and 1.29%.

Radionuclide adsorption kinetics and corresponding  $K_d$ 's were determined on samples of weathered till by Brookhaven National Laboratory. Two samples were analyzed by batch method (ASTM D4319-83) and yielded  $K_d$ 's for  $\text{Cs}^{137}$  of 150 mL/g and 210 mL/g and 38.9 mL/g and 41.9 mL/g for  $\text{Sr}^{85}$ . ( $\text{Sr}^{85}$  was used in place of  $\text{Sr}^{90}$  because of its greater safety factor and similar behavior to that isotope.) As with the surficial sand and gravel, the adsorptive capacity for  $\text{Cs}^{137}$  was found to be much greater than that for  $\text{Sr}^{85}$ .

## Unweathered Lavery Till

- Soil Chemistry

Brookhaven National Laboratory also measured exchangeable base cations on five samples of unweathered till. As with the other units examined, the very high concentrations for  $\text{Ca}^{2+}$  suggest that dissolution of calcite ( $\text{CaCO}_3$ ) may have contributed  $\text{Ca}^{2+}$  to the adsorptive solution, therefore biasing the results. In addition, the percent organic matter in two samples was determined to be 0.95% and 1.07%, respectively.

Samples of unweathered till collected during the 1989-1990 monitoring well installation program were analyzed at Brookhaven National Laboratory. The short-term batch method (ASTM D4319-83) was used to determine  $K_d$ 's for the isotopes  $\text{Co}^{60}$ ,  $\text{Cs}^{137}$ ,  $\text{Sr}^{85}$ ,  $\text{Tc}^{99}$ ,  $\text{Am}^{241}$ , and  $\text{I}^{125}$ . This method involves mixing contaminated solution and geologic material in a reaction vessel. Once equilibrium is reached, the  $K_d$  is determined from the ratio of the concentration of solute on the solid phase to the concentration of solute in solution. Based on the  $K_d$ 's obtained from this testing, the six radionuclides examined can be ranked in order of mobility as:

$$\text{Tc}^{99} > \text{Sr}^{85} > \text{Cs}^{137} > \text{I}^{125} > \text{Co}^{60} > \text{Am}^{241}.$$

### 3.2.4.1 Spectrographic Analysis

Ten soil samples taken from four boreholes were analyzed spectrographically by the USGS Geochemistry and Petrology Branch in 1962. The data are provided in Environmental Information Document Volume I, Geology (West Valley Nuclear Services Co., Inc. March 14, 1996). The distribution of sampling points and the date at which the samples were taken suggest that the data comprise valid baseline geochemical information for the site. They also should be compared to composition of site soils expressed as oxides of the major elements present, as discussed below.

### 3.2.4.2 Major Element Analyses

Major element analyses were performed by the USGS on fifteen borehole samples and eight additional samples taken from excavations in the vicinity of the SDA. The results of these analyses are contained in Environmental Information Document Volume I, Geology (West Valley Nuclear Services Co., Inc. March 14, 1996).

## 3.3 Surface Water and Sediment

The following text describes the surface water bodies of the WNYNSC and its environs and discusses various hydrological and geomorphological characteristics such as erosion, stream channel profiles, and runoff and discharge. Major sources of existing information presented in this section include the Environmental Information Document Volume III, Hydrology (West Valley Nuclear Services Co., Inc. March 12, 1996a,b,c), the WVNS Safety Analysis Report SAR-001 (West Valley Nuclear Services Co., Inc. August 1993), and the annual Site Environmental Reports. Other sources are cited as applicable. SSWMU-specific surface water and sediment contamination data, if available, will be presented in the Surface Water and Sediment Contamination sections of the individual SSWMU RFI volumes.

### 3.3.1 Description of Surface Water Bodies

The WNYNSC lies within the Cattaraugus Creek watershed, which empties into Lake Erie 43.5 kilometers (27 mi) southwest of Buffalo, New York. (See Fig. 2-1.) The WNYNSC includes the WVDP and forest and abandoned farmlands. Buttermilk Creek, a tributary of Cattaraugus Creek, drains the entire WNYNSC, an area of about 13.6 square kilometers (5.3 mi<sup>2</sup>). The confluence of Buttermilk and Cattaraugus Creeks lies within the WNYNSC at its northernmost end. The total Buttermilk Creek drainage area is 75.3 square kilometers (29.4 mi<sup>2</sup>).

The WVDP's drainage basin consists of about 1,200 acres (1.9 sq mi) and is drained by three primary channels: Quarry Creek, Frank's Creek, and Erdman Brook. The three creeks flow generally in a north-northeast direction. Erdman Brook and Quarry Creek are tributaries of Frank's Creek, which in turn flows into Buttermilk Creek. Frank's Creek enters Buttermilk Creek from the southwest about 3.2 kilometers (2 mi) upstream of the Cattaraugus-Buttermilk confluence.

Figure 3-7 shows the proximity of process building operations and disposal areas to the drainage pattern and also illustrates the steep slopes resulting from aggressive downcutting through glacial sediments. The outfall of the watershed is at the confluence of Frank's Creek and Quarry Creek.

Several gullies are located inside the Project area. On-site gullies are described and mapped in Environmental Information Document Volume III, Hydrology, Part 1 (West Valley Nuclear Services Co., Inc. March 12, 1996b).

The till plain that the site is located on is bisected by Erdman Brook. The till plain has an average drop in elevation of approximately 27.4 meters (90 ft) over its 914-meter (3,000-ft) length (3% grade). Quarry Creek drains the largest area north and west of the active site operations, while Frank's Creek, Erdman Brook, and Lagoon Road Creek drain the majority of the process building and the waste burial areas located south of Erdman Brook.

## Erdman Brook

Erdman Brook (140-acre drainage basin) drains most of the land containing the Project facilities, including the wastewater treatment lagoons, part of the radioactive waste burial areas, the equalization pond outfall, most of the old process building, various office trailers, the south parking lot, and the south half of the north parking lot. Erdman Brook flows from an elevation of 546 meters (1,790 ft) NGVD west of Rock Springs Road to 398 meters (1,305 ft) NGVD at the confluence with Frank's Creek northeast of the lagoons. It flows for about 914 meters (3,000 ft) through the Project facilities. The stream channel does not become well defined until it enters the site through a number of culverts passing under Rock Springs Road.

The downstream segment of Erdman Brook is V-shaped and the upstream segment is U-shaped, with a transition zone between the two sections. The transition zone extends from a point east of the southern end of lagoon 2 to a knickpoint near the north slope of the SDA. The transition zone is characterized by a developing forest on the upper stream banks, a low stream gradient, and a relatively flat, cobble-lined channel bed. Resistant clay till is exposed at several spots in the upstream floodplain of Erdman Brook. This clay appears to comprise lumps or pods rather than a flat uniform layer. This section also has a higher gradient (3.2%) compared to the corresponding Frank's Creek area (1.4%). The absence of soil borings in the floodplain precludes commentary on the thickness of modern fluvial deposits in the area. Historical aerial photographs indicate that the transition knickpoint has been moving upstream at a rate of about 3.2 meters (10.5 ft) per year for the past thirty-five years.

## Quarry Creek

Quarry Creek (740-acre drainage basin), receives runoff from the HLWTF, the north half of the north parking lot, and the radioactive waste temporary storage tents. It flows from an elevation of 588 meters (1,930 ft) NGVD west of Dutch Hill Road to 379 meters (1,245 ft) NGVD at its confluence with Frank's Creek. The stream segment along the north side of the Project is about 914 meters (3,000 ft) long. Upstream of old Rock Springs Road, Quarry Creek flows on bedrock. Exposed bedrock is weathered gray shale with numerous vertical joints and is a source of lightweight, readily transportable, angular shale debris. At present the wreckage of the old Rock Springs Road bridge is effectively blocking the downstream transport of this broken shale. Culverts under the present day Rock Springs Road also block this transport to a lesser extent.

## Frank's Creek

Frank's Creek (295-acre drainage basin) receives runoff from the east side of the Project, including the drum cell, part of the state radioactive waste burial area, and the CDDL. It flows into Buttermilk Creek about 610 meters (2,000 ft) downstream of its confluence with Quarry Creek. It flows from an elevation of 546 meters (1,790 ft) NGVD west of Rock Springs Road to 379 meters (1,245 ft) NGVD at the Quarry Creek confluence to 360 meters (1,180 ft) NGVD at the Buttermilk Creek confluence. About 1829 meters (6,000 ft) of its length is adjacent to WVDP facilities. Frank's Creek channel can be divided into three segments:

- From the confluence with Quarry Creek upstream to the WVDP security fence, the stream flows roughly parallel to Buttermilk Creek through a relatively straight channel. This segment is characterized by steep slopes, tree falls blocking the channel, and numerous groundwater seeps. A series of slump blocks of Lavery till nearly occludes the channel near the Quarry Creek confluence.

- From the WVDP security fence to a point east of the northern trenches of the SDA, the creek is meanderform. The steep, forested slopes are similar to the downstream segment, but logjams and seeps are not as common. The stream is generally incised into the Lavery till and numerous cobbles line the channel bottom. Sandy soil can be found within some fringing terraces and channel banks. The channel and adjoining hillslopes along this segment, as along the downstream segment, have characteristic V-shaped transverse profiles.
- At a point east of the northern SDA trenches, stream and hillslope morphology changes from a V-shaped profile with a cobble-lined channel bed to a U-shaped profile with a flat, marshy floodplain. There is essentially no transition zone between these two different channel types; rather, the change occurs abruptly at a knickpoint along the channel profile. The main stream channel on the floodplain is typically a rectangular notch cut into the floodplain.

The main stream channel on the floodplain consists of many small sharp meanders. Slopes adjoining the floodplain evince no appreciable sliding or slumping and apparently are stable. The average slope is about 21 degrees. The floodplain is thickly vegetated with field and marsh grasses. Tree growth is limited by the prevalence of marshes and frequent flooding. Erosion scars, attributed to earlier erosive episodes, are visible on the adjoining hillslopes. The floodplain section continues along the east of the SDA, turning westward beyond the southern end of the burial area. The floodplain gradually broadens to a marsh and disappears in the vicinity of the railroad spur.

Inspection of the knickpoint face and a review of earlier borehole logs indicate alluvium up to 1.5 meters (5 ft) thick below the surface of the floodplain. The types of deposits present suggest that the floodplain is built on modern sediments that built up in the stream channel behind an obstruction on Frank's Creek. The obstruction might have been a landslide, large tree fall, or beaver dam that has since been removed from the stream channel and is now allowing the backed up sediments to be gradually cleared. Stream terraces downstream of the knickpoint are thought to be remnants of the present-day floodplain. Their locations indicate that an obstruction may have been located near the confluence of Erdman Brook. A review of aerial photos indicates that the transition knickpoint between the V- and U-shaped channels has been moving upstream at a rate of about 2.3 meters (7.5 ft) per year for the past thirty-five years.

#### Longitudinal Profiles of Stream Channels

Longitudinal profiles of stream channels were prepared and are described in the Hydrology Environmental Information Document (EID), Volume III, Part 1, Geomorphology of Stream Valleys. (West Valley Nuclear Services Co., Inc. March 12, 1996b.) Frank's Creek was profiled from its confluence with Buttermilk Creek to a point east of the SDA trenches (Boothroyd et al. 1982). The mean gradient was 1.992% (19.92 ft/1,000 ft) with a floodplain section gradient of 1.246% (12.46 ft/1,000 ft). Overall, this is nearly three times the gradient of Buttermilk Creek. Its profile has a general convex shape. The channel has a localized increase in gradient to 4.1% from a point approximately 244 meters (800 ft) below the confluence of Quarry Creek to a point approximately 152 meters (500 ft) above the confluence.

Initial results from the 1989/1990 profiling indicate that Frank's Creek has downcut about 0.61 meters (2 ft) over the past ten years from the Quarry Creek confluence to the F48 knickpoint complex. (See Plate 2 in Environmental Information Document Volume III, Hydrology, Part 1.) Upstream of this knickpoint, in the floodplain area, downcutting has been minimal [less than 0.15 meters (0.5 ft)] over the past ten years.

Although earlier data does not exist to make accurate profile comparisons, Erdman Brook, which has a steeper gradient and greater runoff per unit area than Frank's Creek, probably has a greater downcutting rate. The greater runoff can be attributed to the soil type, amount of urbanized area, and additional sources of discharge from lagoon 3 and the equalization pond. The nonbedrock channel section of Quarry Creek, despite having a steeper gradient, probably has a lower downcutting rate (compared to Erdman Brook) because it has a less urbanized watershed.

Buttermilk Creek was profiled between the abandoned Bond Road and Buttermilk Road bridges. The mean gradient was 0.676% (6.76 ft/1,000 ft). The lower stream section that has cut down to bedrock exhibits a lower gradient than the upper reaches. The gradient over bar complexes was also noted to be lower than the mean.

Hydrologic modeling of the watershed containing the entire WVDP site area by SCS TR-55 and TR-20 methods has included detailed analysis of its constituent subareas. Subarea delineations, areal determinations, soil types, cover treatments, and times of concentration have been computed and the results are available in Environmental Information Document Volume III, Hydrology, Part 2 (West Valley Nuclear Services Co., Inc. March 12, 1996c).

Modeling of the nearly 5.1 square kilometers (2 mi<sup>2</sup>) of watershed and its constituent subareas has generated discharge rates at forty-six selected locations for three synthetic storms (2-, 10-, and 100-year frequency). It has been roughly estimated that the 100-year peak discharge for the watershed has increased 50% from 1961 to 1991. This increase can be attributed to development of the Project and related facilities, which has resulted in increased runoff. Such development has been restricted to roughly 20% of the watershed, but its impact is particularly acute immediately downstream of the facilities, where the percentage increase in discharge over pre-existing conditions is greater than 50%. In many of these areas, woods and pastures have been replaced by impervious areas (paving, buildings).

Hydraulic modeling of the 100-year floodplain has determined that the four main culverts on-site and their associated reservoirs perform safely without overtopping their embankments. Water surface elevations for the 100-year storm have been mapped and shown to be clear of all facilities. The most significant effect of the increased runoff appears to be the exacerbation of stream velocities, which are eroding several sensitive reaches.

Precipitation, a major contributor to flow in area streams, averages more than 101.6 centimeters (40 in) per year and is discussed in section 3.4.2, Climatology, and section 3.4.3, Meteorology, of this document.

### Surface Impoundments

Various surface impoundments associated with wastewater treatment are located on-site. The LLWTF includes four in-series open lagoons (lagoons 2, 3, 4, and 5). Lagoon 2, the first impoundment in the configuration, had original dimensions of 85.3 meters by 59.4 meters by 5.2 meters (280 x 195 x 17 ft) and the design capacity was 9,084,000 liters (2,400,000 gal). Due to silting and the deposition of sludge removed during lagoon 1 closure, lagoon 2 may no longer accommodate this same capacity. Lagoon 2 is generally operated at 70% - 80% of its original design capacity or 6,359,000 to 7,343,000 liters (1.68 - 1.94 x 10<sup>6</sup> gal).

Lagoons 4 and 5 are lined impoundments with dimensions of 22.6 meters by 30 meters by 1.8 meters (74 x 100 x 6 ft). Lagoon 4's capacity is 772,140 liters (204,000 gal) and lagoon 5's capacity is 628,300 liters (166,000 gal).

Lagoon 3 is the final lagoon in the system before wastewater is discharged into Erdman Brook via SPDES-permitted outfall 001. The original dimensions were 85.3 meters by 59.4 meters by 7.3 meters (280 x 195 x 24 ft), and the holding capacity was calculated at 12,490,000 liters (3,300,000 gal). Standard operating procedures (SOPs) ensure that the stored volume of lagoon 3 does not exceed 80% of the design volume.

Another active surface impoundment, the equalization basin, is a part of the WVDP's nonradioactive sanitary wastewater treatment system. The basin is 15.2 meters by 36.6 meters by 2.4 meters deep (50 x 120 x 8 ft) and has a 624,530 liter (165,000 gal) capacity. The wastewater is discharged into a gully that flows into Erdman Brook via SPDES-permitted outfall 007.

Two demineralizer ponds exist approximately 45.7 meters (150 ft) to the east of the old warehouse and about 122 meters (400 ft) southeast of the process building. Each pond is an unlined, rectangular basin about 30 meters by 15 meters (100 ft x 50 ft) wide and about 1.5 meters (5 ft) deep, with the east end being slightly deeper than the west end.

The two ponds were part of the original fuel reprocessing process building that was built in the mid-1960s. When first constructed, the ponds discharged through a weir box and underground piping to the head of a gully (sewage outfall gully) that drained to Erdman Brook. The discharge was SPDES-permitted as outfall 005. The ponds are currently out of service with no open discharge point.

Two water supply reservoirs for the WVDP are located to the south of the WVDP. The reservoirs lie in a separate watershed from the facilities and are also drained by Buttermilk Creek.

### 3.3.2 Description of Surface Water and Sediment Chemistry

As part of the on-site environmental monitoring program, surface water samples are collected from the tributaries of Cattaraugus Creek that flow through the 3,300-acre WNYNSC and from drainage channels within the Project site. A majority of the existing sampling locations are analyzed for radiological parameters. Selected samples collected from certain locations are analyzed for nonradiological parameters.

Surface water samples are also collected and analyzed for water quality parameters at three SPDES outfall locations within the WVDP.

Sediment samples for nonradiological parameters are not routinely collected as part of the environmental monitoring program. Sediment samples have been collected at times from on-site streams and lagoons for specific purposes, and the information includes data on various nonradiological parameters. When available, this data will be presented in the Surface Water and Sediment Contamination sections of the individual SSWMU RFI volumes. Locations of surface water and sediment sampling as part of the environmental monitoring program are found in the annual Site Environmental Monitoring Reports.

### 3.3.3 Evapotranspiration

Evapotranspiration at the WVDP was estimated using several methodologies that used air temperature and rainfall data, soil moisture profiles, and biologic factors. Simple analytic and seminumeric models as well as literature values (Kappel and Harding 1987; Yager 1987) determined a range of evapotranspiration values for both the north and south plateaus.

Based on an average annual rainfall of 100.57 centimeters (39.6 in), which was reduced to average monthly data, and monthly air temperature data from the WVDP, an average annual evapotranspiration of 56.56 centimeters (22.3 in) was calculated via the Thornthwaite equation with the WATERBUD code (Sharpe et al. 1985). This value compares with similar values for western New York in van der Leeden et al. (1991), which estimated regional evapotranspiration between 53 and 68.6 centimeters (20.9-27 in) per year. Additionally, Kappel and Harding (1987) estimated evapotranspiration on the north plateau at 45 cm/yr (13.7 in/yr), based on a total precipitation of 100 cm/yr (39.4 in/yr), and Yager (1987) estimated annual evapotranspiration at 46 centimeters (18.1 in) based on a total precipitation of 92 centimeters (28 in).

A 1990 and 1991 CREAMS (U.S. Department of Agriculture 1984) model analysis of the north plateau has determined evapotranspiration to be 45.72 centimeters (18 in) for 1990 (of 112 cm (44 in) total precipitation) and 34.43 centimeters (13.6 in) for 1991 (of 78.8 centimeters (31 in) total precipitation); for the south plateau evapotranspiration was 46.13 centimeters (18.2 in) for 1990 and 38.45 centimeters (15.1 in) for 1991. A SWIM (Ross, P.J. 1990) model analysis from March 1990 to March 1991 and from March 1991 to March 1992 determined north plateau evapotranspiration to be 51.5 centimeters (20.3 in) [130 centimeters (51.2 in) total precipitation] and 43.4 centimeters (17.1 in) [80.5 cm (31.7 in) precipitation], respectively. A similar analysis of the south plateau determined 1990 and 1991 evapotranspiration to be 53.9 centimeters (21.2 in) and 44.9 centimeters (17.7 in), respectively.

In general, these data indicate that evapotranspiration depletes approximately 47% of the total precipitation falling on the north plateau and approximately 48% of the precipitation falling on the south plateau.

#### 3.3.4 Sediment Characteristics

Fluvial sediment derived from the NDA area moves downstream by two mechanisms: traction and suspension. Bedload (coarser sediments) is transported by traction and suspension transports the finer fraction. Transport velocities for suspended and bedload sediments differ greatly. Sand and larger particles can require years to travel the same distances that suspended clay particles travel in a single storm event. Walters et al. (1982) reported sand-silt-clay percentages for bedload samples in Frank's Creek to be 28%, 69%, and 3%, respectively. For the same location and phase of sampling, suspended sediment distributions consisted of 1% sand, 88% silt, and 11% clay.

Historical studies of fluvial sediment at the WNYNSC have focused on radionuclide sorption by sediments. Walters et al. (1982) summarized the findings of their study, which had as its nearest sampling point a location on Frank's Creek near its confluence with Buttermilk Creek.

Although there are no site-specific analyses of fluvial sediment for organic or inorganic constituents, their concentrations can be expected to be greater in the silt-and-finer population where the organic content is presumably greater and where cation exchange sites exist in the clay minerals.

In 1979 bed sediment samples (Walters et al. 1982) were analyzed by Pacific Northwest Laboratories (PNL), including particle size differentiation. The closest sample points to the site facilities were at the confluence of Frank's Creek and Buttermilk Creek and a point slightly below the first tributary downstream of Quarry Creek on Frank's Creek. Although these particular samples were inconclusive as far as presenting consistent characteristics between the amount of a particle size and a flowrate, the overall trend for all the samples taken in the Cattaraugus Creek basin tended to show higher percentages of clay and silt at the lower flow rates. This

is reasonable as the smaller particles are expected to be drawn into the stream flow first as flowrate increases and to remain in suspension longer as the flowrate decreases.

### 3.4 Air

The following text describes the climate and atmospheric conditions investigated through the review of historical and ongoing meteorological monitoring data. This investigation focused on regional climatology and local meteorology, including the on-site monitoring program, in order to assess the parameters necessary to model the flow pattern of potential airborne releases. SWMU-specific air contamination data, if available, will be presented in the Air Contamination sections of the individual SSWMU RFI volumes.

Air effluent has been monitored for radiological parameters since the NFS process building became operational, but because of the lack of significant use of chemicals, monitoring for nonradiological parameters has been limited to that required for nitrogen oxides (NO<sub>x</sub>) emissions from the vitrification testing operations.

Ambient air is monitored on a site-wide basis for particulate radioactivity by five perimeter and four remote samplers. A sixth perimeter location at the bulk storage warehouse was added to the program in December 1992. Complete data for all years can be found in the WVDP annual Site Environmental Reports from 1982 to the present.

Nonradioactive emissions from WVDP operations are controlled and permitted under New York State and EPA regulations. The WVDP permits are for minor sources of regulated pollutants including particulates, nitric acid mist, oxides of nitrogen, and sulfur. Part 212 of 6NYCRR provides that continuous monitoring is not required for sites such as the WVDP, which are minor sources of these pollutants. Nevertheless, the WVDP has developed a nonradiological emission inventory for 1993 to support documentation required by the 1990 Clean Air Act Amendments and NYSDEC Air Emission Inventory requirements (Dames & Moore March 21, 1994).

#### 3.4.1 Topographic Features Affecting Air Flow

The topography of western New York exerts an influence on the climate of the region. The WVDP is situated in western New York State at approximately 42° 27' north latitude, 78° 39' west longitude, and at an elevation of approximately 427 meters (1,400 ft) above mean sea level. Major bodies of water in the region include Lake Erie, located approximately 48 kilometers (30 mi) northwest of the site, and Lake Ontario, whose southern shore lies approximately 97 kilometers (60 mi) to the north. Numerous smaller bodies of water lie within a 80-kilometer (50-mi) radius of the site. Topographic relief over the region is quite varied. A relatively flat lake plain is present along Lakes Erie and Ontario. The Lake Erie plain extends inland about 32 kilometers (20 mi). The West Valley site lies in the Appalachian Plateau, which is the dominant highland feature of much of southern New York and northern Pennsylvania. This area is characterized by glacially scoured landscapes with deep river valleys and gorges scattered throughout. Elevations in the region range from approximately 183 meters (600 ft) along the shore of Lake Ontario to the north to more than 640 meters (2,100 ft) in the hills to the east, south, and immediate north. In the site vicinity, elevations range from about 366 meters (1,200 ft) in the valley carved by Cattaraugus Creek approximately three-quarters of a mile to the north and east to 640 meters (2,100 ft) on nearby hill tops. The site occupies a fairly level plateau at an elevation ranging from 420 meters (1,380 ft) to 433 meters (1,420 ft) MSL.

### 3.4.2 Regional Climatology

The National Weather Service (NWS) observing stations at Buffalo and Jamestown have the most complete data record for the western New York State region. West Valley, as represented by Buffalo, is located near the mean position of the polar front end, so the weather is variable. The normal wide swings of seasonal temperature are moderated somewhat by the influence of Lakes Erie and Ontario. Topography and the proximity to large bodies of water often cause marked variations in temperature, precipitation, and sunlight in areas only a few miles apart. Continental polar and arctic air waves moving southeast from source regions in northwest Canada traverse the area. Passing over the lakes, the air masses pick up heat and moisture that may lead to heavy snowfalls in only a few hours along the shores of the lakes and on higher ground farther inland.

The coldest temperature in most winters varies between  $-21^{\circ}\text{C}$  ( $-5^{\circ}\text{F}$ ) and  $-23^{\circ}\text{C}$  ( $-10^{\circ}\text{F}$ ) near the Great Lakes;  $-21^{\circ}\text{C}$  ( $-5^{\circ}\text{F}$ ) to  $-26^{\circ}\text{C}$  ( $-15^{\circ}\text{F}$ ) in the Finger Lakes and Chemung River Valley; and  $-23^{\circ}\text{C}$  ( $-10^{\circ}\text{F}$ ) to  $-29^{\circ}\text{C}$  ( $-20^{\circ}\text{F}$ ) in the southwestern highlands. Extreme winter temperatures as cold as  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ) have been recorded in the higher elevations of Cattaraugus and Allegany Counties. Severe winter cold with below zero minimums and/or lengthy periods of continuous subfreezing temperatures occur between early December and mid-March. Winter thaws result in temperatures from  $4^{\circ}$  to  $10^{\circ}\text{C}$  ( $40^{\circ}$  -  $50^{\circ}\text{F}$ ) for a few days at a time, with rare maximums in excess of  $16^{\circ}\text{C}$  ( $60^{\circ}\text{F}$ ).

The winter climate of western New York is marked by abundant snowfall. The areas with the lightest snowfall, with average seasonal accumulations of 101.6 to 127.0 centimeters (40 to 50 in), are the lower Chemung Valley, the western Finger Lakes, and northern Niagara County. The heaviest snowfall occurs in the eastern lee of Lake Erie, where the average total is in excess of 304.8 centimeters (120 in). The snow season normally begins in mid-November and extends into mid- or late March. Snow cover is continuous from early December until the middle of March, although occasional midwinter thaws greatly reduce or eliminate the cover for brief periods.

The summer season is cool in the southwestern highland. High temperatures and high humidity are infrequent during the summer and seldom persist for more than a few days at a time. Temperatures of  $32^{\circ}\text{C}$  ( $90^{\circ}\text{F}$ ) or higher are recorded on five days or less per year at the higher elevations and along the shores of the Great Lakes, but the remainder of western New York has an average frequency of eight to fifteen days. Such temperatures occur between early June and early September. Readings of  $38^{\circ}\text{C}$  ( $100^{\circ}\text{F}$ ) or higher are rare. The range of temperature on summer days is commonly from near  $16^{\circ}\text{C}$  ( $60^{\circ}\text{F}$ ) at night to  $27^{\circ}\text{C}$  ( $80^{\circ}\text{F}$ ) in the afternoon.

Summer season precipitation increases to the south, ranging from about 20 centimeters (8 in) along the Lake Ontario shore to 5 to 30 centimeters (2 to 12 in) in the counties along the Pennsylvania border. Showers and thundershowers account for much of the warm season rainfall and the distribution pattern reflects the contrasting influences of the cool Lake Ontario waters to the north and the hilly terrain in the Southern Tier.

Temperatures rise gradually during the spring season and in some years the warming trend is delayed by recurring periods of cool weather. The cold water of the Great Lakes reduces daytime warming, and frequent cloudiness moderates both extremes of the diurnal temperature cycle.

The influence of the Great Lakes is diminished in the southern half of the region, where the chance of a damaging frost remains high through the middle of May.

The autumn season is marked by frequent periods of sunny, dry weather. Summer warmth persists until about mid-September, but temperatures noticeably decline as the hours of darkness rapidly increase. With less cloud cover, temperatures from mid-September to mid-October frequently rise to the 16°C to 22°C (60°-70°F) in the daytime and cool to the 0°C to 6°C (30°-42°F) at night. The comparatively warm waters of the Great Lakes reduce cooling at night to the extent that freezing temperatures in lakeside counties are normally delayed until mid-October or later.

### 3.4.3 Local Meteorology

In order to evaluate the possible migration pathways of effluents produced by Project activities and released into the atmosphere, a knowledge of local meteorological parameters is essential. The capacity of the atmosphere to dilute and disperse effluents is of prime importance in evaluating the environmental effects of site operations under both normal and abnormal conditions. The dispersive capability of the atmosphere depends on many parameters. These parameters include such meteorological variables as temperature, wind speed and direction, precipitation, and relative humidity. Off-site data for representation of the general local meteorological conditions have been taken from the NWS observing stations at Buffalo and Jamestown, New York. Six years of continuous monitoring data (1984-1989) has been compiled from the NWS and from the WVDP in order to compare results. Positive correlations are important because they indicate that Buffalo data may be used in estimating possible site-specific migration pathways in the event of WVDP monitor failures. On-site data is obtained from primary and regional meteorological monitoring towers. Data were taken as reported in the WVDP annual Site Environmental Reports and the Safety Analysis Report, Volume 1, Project Overview and General Information, (West Valley Nuclear Services Co., Inc. August 26, 1996).

#### On-site Meteorological Program

An environmental surveillance program was initiated in accordance with DOE Orders in 1982. Wind and temperature data have been collected from the WVDP primary and regional meteorological towers since October 1983. On-site precipitation and barometric pressure have been monitored since 1985. The meteorological data from 1984 through 1989 were used to describe on-site and regional climatology, with the exception of precipitation and barometric pressure, where updated data has been added. Although data continues to be collected, it is not anticipated that it would vary significantly from the data presented.

The primary on-site meteorological tower measures atmospheric dispersion parameters at 10-meter (33 ft) and 60-meter (197 ft) elevations above ground level. The regional site is a 10-meter (33 ft) tall wooden telephone pole located on Dutch Hill, approximately 5.2 kilometers (3.2 mi) south-southwest of the Project facilities. Additionally, a chart-recording microbarograph and a digital, tipping bucket, heated rain gauge are maintained at a location near the site meteorological tower. Sensors for dew point and barometric pressure measurement were added in late 1991.

#### Wind Speed and Direction

Wind speed and wind direction data are monitored at the 10-meter (33 ft) and 60-meter (197 ft) levels of the primary WVDP tower and at the 10-meter (33 ft) level of the regional tower. NWS wind data are usually monitored at a 10-meter (33 ft) level. Because of surface friction the 10-meter (33 ft) wind speed measured at the primary tower is consistently lower than the 60-meter (197 ft) level. From 1984 to 1989 the monthly average wind speed ranged from 1.7 to 3.4 meters per second (mps) (5.6-11.2 ft/s), 3.0 to 5.5 mps (9.8-18 ft/s), and 2.9 to 6.2 mps (9.5-20.3 ft/s) at the primary 10-meter (33 ft), 60-meter (197 ft), and regional

monitors, respectively. Like the monthly averages, the 60-meter (197 ft) maximum wind speed is higher than that measured at the 10-meter (33 ft) level, while regional maximum wind speed data is comparable to the 60-meter (197 ft) level of the primary tower. The regional tower is at a higher elevation, approximately 180 meters (590 ft) above the elevation of the site. Average annual wind speed at Buffalo is 5.5 mps (18 ft/s) and slightly less at West Valley because of the sheltering effect of the moderate terrain features. Table 3-4 shows the average monthly wind speeds and the maximum recorded wind speeds and corresponding directions at Buffalo.

Though the proximity to numerous hills near the WNYNSC will modify windflow somewhat, wind direction from all WVDP permanent monitors is predominantly from the southwest sectors. Wind roses have been prepared at various times since 1973 and are on file at the WVDP. A special monitoring program to evaluate local wind flow was conducted from October 1983 through September 1984 using five remote locations. Wind flow patterns that can be expected because of terrain influences along with the data from this study are presented in a topical report (Christenson et al. September 1986).

Tables 3-5 and 3-6 contain meteorological data collected on-site at the primary location and meteorological data collected from the Buffalo NWS Station from 1984 through 1989. Table 3-6 contains the maximum wind speeds recorded at the WVDP and Buffalo for the same years. A positive correlation of the wind data from the two monitoring stations is apparent, based on six years of continuous monitoring data. It should be noted that Buffalo wind speed, direction, and temperature are instantaneous readings, whereas the WVDP data are hourly averages.

#### Temperature

Temperatures show extreme seasonal variations in western New York. The monthly average temperature data (1984 to 1989) for the WVDP and Buffalo are provided in Table 3-7. A high degree of correlation appears to exist between the WVDP's and Buffalo's average monthly temperature, based on six years of continuous monitoring data. As expected, WVDP monthly averages are slightly lower than Buffalo averages by approximately 1°C to 2°C because of the higher elevation of the WVDP in relation to Buffalo. WVDP monthly temperature averages from 1984 to 1989 ranged from 21.0°C to -7.9°C. Maximum and minimum monthly temperatures (1984 - 1989) for the WVDP and Buffalo are provided in Tables 3-8 and 3-9. The maximum and minimum temperatures measured at the WVDP during 1984 through 1989 were 33.6°C and -26.9°C, respectively.

#### Annual and Monthly Rainfall Averages (Snowfall-water equivalent)

Precipitation is fairly well distributed throughout the year with much of the winter precipitation occurring as snowfall. Topographic relief plays a major role in influencing snowfall. West Valley lies within an area receiving an annual average snowfall of approximately 305 centimeters (120 in).

Precipitation data have been continuously monitored on-site since 1985. Monthly WVDP and Buffalo precipitation for 1985 through 1991 are noted in Table 3-10. Mean annual precipitation (meltwater equivalent) for the years 1985 to 1989 was approximately 101.1 centimeters (39.8 in) at the WNYNSC as shown in Table 3-11. Data are also available through the Buffalo office of the National Weather Service. Because Buffalo precipitation is highly influenced by moisture from Lake Erie, there is very little correlation between the WVDP and Buffalo.

## Relative Humidity

Relative humidity varies diurnally with temperature and changes with the absolute amount of water vapor present in the air. Relative humidity during predawn hours averages 79% to 83% throughout the year at Buffalo, New York. Afternoon relative humidity averages 67% to 77% during the winter, dropping to 55% to 60% during summer months. Values at the WNYNSC probably do not differ from those at Buffalo by more than 2% or 3% since the region as a whole is generally humid. The West Valley values may be slightly lower because the location is some distance from Lake Erie. Sensors for dew point were added to the on-site meteorological program in 1991.

## Barometric Pressure

Sensors for barometric pressure measurement were added to the on-site meteorological program in February 1991. Data for March 1991 through March 1992 were reviewed. Monthly averages (inches Hg) range from 29.93 in March 1992 to 30.20 in May 1991. The highest reading for this period was 30.67 on December 19, 1991 and the lowest reading was 29.51 and occurred on both March 4, 1991 and March 11, 1992.

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## 4.0 Potential Receptors

The following text describes the human populations and environmental systems that are susceptible to contaminant exposure from waste constituents that may be present in the SWMUs.

### 4.1 Contaminant Transport Pathways

One of the potential mechanisms of contaminant transport from the SWMUs at the WVDP is movement through groundwater to surface streams. Other potential pathways include erosion of contaminated soils with subsequent movement of contaminants to surface streams, storm water runoff of surface contamination, and atmospheric transport of particulates or gases. The following summarizes significant aspects of the potential pathways as they relate to mechanisms through which humans and environmental receptors may be exposed to contaminants from the SWMUs at the WVDP. The conceptual models provided in Figures 4-1 and 4-2 illustrate potential migration pathways and associated potential exposure routes for contaminants that may emanate from a given SWMU located on either the north or south plateau of the WVDP.

#### Groundwater Transport

The north plateau of the WNYNSC is characterized geologically by surficial deposits ranging up to 12 meters (40 ft) thick of relatively permeable silty gravel. This permeable layer is underlain by essentially impermeable unweathered Lavery till. Groundwater within the north plateau flows predominantly horizontally through the silty gravel unit in a northeast direction, with discharge occurring 30 meters (100 ft) downgradient at seepage zones along the Frank's Creek Valley. The primary sources of groundwater recharge include infiltrating precipitation and groundwater inflow from bedrock immediately west of the north plateau. High ground on the west and Frank's Creek Valley on the east isolate the north plateau groundwater systems and preclude off-site migration through this water-bearing unit. Thus, the major pathway through which groundwater contaminants originating from SWMUs within the north plateau could move off-site is via discharge to the surface water system.

Surface water drainage from the north plateau flows to Quarry Creek, Frank's Creek, and Erdman Brook. These creeks ultimately drain into Buttermilk Creek, which flows into Cattaraugus Creek 4.15 kilometers (2.6 mi) northwest of the WVDP. Access to Buttermilk Creek is restricted and human exposure to the waters of Cattaraugus Creek is limited primarily to recreational use and sport fishing. Neither Buttermilk Creek nor Cattaraugus Creek downstream of the WNYNSC are used as sources of potable water. (See Section 4.2.4 for a more detailed description of water use.)

The water table beneath the south plateau occurs in the upper 4.5 meters (0 to 15 ft) of the Lavery till. Groundwater flow within the Lavery till is mainly vertical to the Kent recessional sequence. The upper, weathered portion of the Lavery till exhibits a horizontal flow, which enables groundwater to move laterally. Some laterally moving water eventually percolates downward into the underlying unweathered till. High ground to the west of the WVDP and Buttermilk Creek Valley to the east each intersect this water-bearing unit, precluding off-site migration of groundwater. Several shallow, isolated water-transmitting strata also occur at various other locations within the site boundary but do not appear to be continuous enough to provide avenues for the movement of groundwater from on-site to off-site areas. Thus, the major pathway for movement of contaminants in the groundwater off-site is via surface water drainage. All surface drainage from the WNYNSC is to Buttermilk Creek, which flows into Cattaraugus Creek (which is approximately 3.8 kilometers (2.4 mi) northeast of the NDA at its nearest approach) and ultimately into Lake Erie.

## Soils Transport

The most significant pathways for movement of soil contaminants off-site are via erosion into surface waters or leaching of soil constituents into groundwater with subsequent discharge to surface waters. Exposure to soil contaminants via dermal contact or inhalation of contaminated dusts and particulates is expected to be minimal because groundcover is carefully maintained at the WVDP SWMUs and public access to this area is restricted. However, these latter exposure pathways could become important if the soils of the SWMUs were to be excavated. The transfer of contaminants to humans through food crops grown on this land or through domestic livestock grazing on this land is not a potential exposure route based on current land use conditions.

## Air Transport

Dispersion of particulate or vapor contaminants at the WVDP via the atmosphere represents another potential exposure pathway. Under current landuse conditions, the atmospheric transport of particulates is not considered a significant exposure pathway but, as mentioned above, this could become important if excavation activities were undertaken at the WVDP. Based upon historical information concerning the SWMUs at the site, emission of toxic vapors is also believed not to represent a significant route of exposure. (Section 3.4 of this volume details air quality and air monitoring activities at the WVDP.)

## Other Transport Pathways

Other potential pathways by which humans could be exposed to contaminants originating at the WVDP include consumption of agricultural products grown in areas affected by the WNYNSC or consumption of game animals and fish that include the WNYNSC in their range. The potential exists for exposure via the former pathway since the public areas surrounding the WNYNSC are predominantly agricultural. However, water use patterns along Cattaraugus Creek indicate that water from Cattaraugus Creek is not used to irrigate food crops or as a primary water source for livestock. Livestock do have access to Buttermilk Creek near the confluence of Cattaraugus Creek. (See Section 4.2.4.) With respect to exposure to contaminants via game meats and fish, the most plentiful species of game animal on the WNYNSC is the Virginia white-tail deer. However, consumption of venison is probably not a significant route of exposure because hunting was not permitted on site land before 1994. From 1994 through 1996 controlled deer hunting was permitted on the WNYNSC. The WVDP routinely analyzes venison from the WNYNSC for concentrations of radioactivity as part of its environmental monitoring program. The concentration of radioactivity in deer has traditionally been at or below background concentrations. Ingestion of fish that include surface waters affected by the site represents a potentially more significant route of exposure to contaminants. However, game fish species typically caught for human consumption (salmon, trout, walleye, and bass) are not plentiful in Cattaraugus Creek close to the WNYNSC, but, rather, are found predominantly in the lower reaches of Cattaraugus Creek nearer Lake Erie.

## 4.2 Potential Human Receptors

Currently, there is no evidence indicating that human populations have been exposed to RCRA hazardous wastes or hazardous constituents as a result of releases of contaminants from SWMUs at the WVDP.

However, there are three human populations that represent potential receptors in the event of a release of contaminants from SWMUs at the site: 1) operator personnel working in the specific SWMUs at the WVDP; 2) other WVDP personnel; 3) the general population surrounding the site. A discussion of potential human receptors as it relates to operation personnel working at specific SWMUs will be addressed in RFI Volumes ~

through 10. The following summarizes the potential for other WVDP personnel and the general population to be exposed to contaminants at the WVDP as determined by the land and water-use patterns associated with each population.

#### 4.2.1 On-Site Personnel

Personnel at the WVDP have limited physical access to specific areas of the Project premises because there are numerous radiologically controlled areas. Physical barriers and security control devices limit access by nonauthorized personnel. Personnel entering restricted/controlled areas must first be trained as to the hazards of working in the area. This training includes RCRA considerations as they relate to the use of appropriate protective equipment. Consequently, the potential for exposure to personnel is minimal. Groundwater is not used at the plant for process or drinking water supplies and therefore the potential for ingestion as a major transport pathway is minimized. Thus, the major potential pathway of exposure for on-site personnel, from a RCRA perspective, is atmospheric dispersion of vapors and particulates.

#### 4.2.2 General Population

Approximately 200 acres of the WVDP, i.e., the Project premises, is enclosed by an 2.4 meter (8 ft) high security fence. The entire perimeter is patrolled on a random schedule but at least once every eight hours by a guard force. All personnel entry and exit gates are equipped with radiation screening devices. Security systems and devices, including entry badge systems, intrusion and detection alarms, package searches and, as previously mentioned, guard patrols, limit the potential for unauthorized entry to the WVDP facility.

The closest point of general public access to the site is Rock Springs Road, which traverses the WNYNSC. The population within a 16 kilometer- (10 mi-) radius of the WNYNSC is noted in Table 4-1. This area encompasses parts of both Cattaraugus and Erie Counties. Cattaraugus County is predominantly rural and contains thirty-two townships and sixteen villages. It is 3,460 square kilometers (1,335 sq mi) in size and has a population density of twenty-five persons per square kilometer. The county population occurs primarily in rural residential areas and in villages with populations of less than 2,000. There are two incorporated cities in Cattaraugus County: Olean (population 18,207), located 43.5 kilometers (28 mi) southeast of the site and Salamanca (population 6,890), located 32 kilometers (20 mi) south of the site. Erie County, population of 1,015,472, is not as homogenous as Cattaraugus County. The southern third of Erie County, near the WNYNSC site, consists of rural townships in which the population is concentrated primarily in small villages and along roadways.

The nearest village to the WNYNSC is Springville, located in Erie County 5.6 kilometers (3.5 mi) north of the site. Springville had a 1990 resident population of 4,310. The only other village within 16 kilometers (10 mi) of the site is Delevan, located in Cattaraugus County, 14.5 kilometers (9 mi) east-northeast of WNYNSC. In 1990, Delevan had a resident population of 1,214, up 9.1% from 1980. The nearest hamlets are more than 5 kilometers (3 mi) away from the WNYNSC. Hamlets, because they are unincorporated, do not have defined boundaries; thus, population statistics are generally unavailable. A recent survey of the West Valley area (McNeil and Siepel 1992), which is located approximately 5.5 kilometers (3.4 mi) southeast of the site, identified a resident population of 1,049, making it one of the most populous unincorporated areas in the Town of Ashford. Because the WNYNSC vicinity is rural, there are few places where the population is grouped in large numbers except for the schools and hospital in Springville and the Town of Ashford (Table 4-2). There is also a small but significant seasonal transient population associated with the area's numerous small recreation

sites. The population density (persons per sq mile) averaged by distance from the site to a radius of 48 kilometers (30 mi) is as follows:

<b>Persons per Square Mile</b>	<b>Radius (mi) from site</b>	<b>Radius (km) from site</b>
5	1	1.6
18	2	3.2
24	3	4.8
56	4	6.4
88	5	8.0
180	30	48

As the table above indicates, the farther from the site, the greater the population density, reflecting the rural nature of the area near the site and quantitatively indicating a minimal potential for exposure for the general population.

#### 4.2.3 Land Use Patterns

The land within 8 kilometers (5 mi) of the WNYNSC is used primarily for agriculture and aboriculture. The major exception to this agricultural pattern is the Village of Springville, which is residential and commercial. Other major nonagricultural land uses in the site vicinity are as follows: 1) hamlet of West Valley - residential, 5.5 kilometers (3.4 mi) to the southeast; 2) county forest - 6 kilometers (3.75 mi) to the south; 3) campground - 8 kilometers (5 mi) to the southwest. The dominant agricultural activity is related to the dairy industry, with meat production occurring on a smaller scale. Agricultural lands cultivated to produce fruits and vegetables are not as prominent as cropland or pastureland. Fruit and vegetable fields also tend to be smaller than dairy fields and are not distributed in proportion to the occurrence of farmland in general; rather, it has been determined that a few towns contain a disproportionately large share of fruit and vegetable fields. Crops include lettuce, cabbage, broccoli, spinach, snap beans, tomatoes, sweet corn, potatoes, grapes, and apples. Total land area devoted to such production in Erie and Cattaraugus Counties is estimated at 4,152 and 939 hectares (10,250 and 2,320 acres), respectively.

#### 4.2.4 Water Use

Upper Cattaraugus Creek extends from Springville to Gowanda, 32 kilometers (20 mi) downstream of the site, and lower Cattaraugus Creek extends from Gowanda to Lake Erie, 62 kilometers (39 mi) downstream from the site. In 1974, NFS conducted a survey to confirm land and water use in and near Cattaraugus Creek from the confluence of Buttermilk Creek to Lake Erie. As a result of the survey, it was concluded that land-use patterns downstream of the site are predominantly rural. Cattaraugus Creek is not used as a source of water for irrigation of food crops; however, surface water from the creek is used for limited irrigation of golf course greens and tree farms. Cattaraugus Creek is also not used routinely to water livestock, although on one farm located 4 kilometers (2.5 mi) downstream of WNYNSC at the confluence of Buttermilk and Cattaraugus Creeks, grazing dairy cattle do have access to these surface waters. However, radiological monitoring of the milk obtained from these cows suggests that exposures to contaminants are negligible. No public water supply is drawn from the Cattaraugus downstream of the WNYNSC. The creek is not developed for organized water-contact recreation activities, although it is used locally for swimming. Sport fishing occurs primarily near the mouth of the creek at Lake Erie and, to a much lesser extent, at the Springville Dam. Boating is generally

limited to the stretch of water within 3 kilometers (1.9 mi) of the mouth of the creek; occasional canoeing occurs at Zoar Valley, west of the site, when the water depth permits.

Groundwater usage within 3 kilometers (1.9 mi) of the WNYNSC was surveyed in 1982. The tabulated data in Table 4-3 indicate that the vast majority of the wells identified in this area serve residences and farms, and the maximum number of persons served per well is ten. Approximately 85% to 90% of these wells are within the Buttermilk Creek drainage basin and thus tap the same type of groundwater systems that underlie the site. A large percentage of the wells are located on the higher elevations east and west of the WNYNSC along the principal north-south county roads. Supply wells on the uplands west of the WNYNSC, such as along Route 240 and Dutch Hill Road, typically are completed in bedrock.

The tabulated data and the glacial geologic map (West Valley Nuclear Services Co., Inc. March 14, 1996) indicate that a nominal 15 meters (50 ft) of Kent till overlie a fractured bedrock aquifer on the summit levels west of the site, and comparison of screen depths and static water levels indicates that the aquifer underlying the site is confined. A similar situation exists on the uplands east of the WNYNSC, except that most of these wells intersect from 20 to 45 meters (70 to 150 ft) of Kent till and ground moraine above their completion depths in shale bedrock. The data also suggest that pressure head in the bedrock aquifer in this area is greater than along Dutch Hill Road on the west. Groundwater supplies in both of these areas can be assumed to be isolated hydraulically from groundwater in bedrock at lower elevations beneath the WNYNSC.

A second concentration of wells can be found on the lowlands north of the WNYNSC in the vicinity of Bond Road and Thomas Corners Road. These water supplies derive mainly from springs and shallow dug wells completed in the Defiance outwash that overlies the Lavery till in this area. The distribution of springs and the general geologic relationships indicate that the groundwater system here is perched above the Lavery till and that flow patterns are much the same as those that characterize the north plateau at the WNYNSC. However, because the north plateau is deeply incised by Frank's Creek, Quarry Creek, and Buttermilk Creek, the wells that tap into the hydrostratigraphic unit north of the site are clearly disconnected both hydraulically and topographically from the groundwater systems underlying the WNYNSC.

#### 4.2.5 Fish Harvests

Since 1960, New York commercial fishing has focused on walleye and yellow perch. In 1990, four licenses for commercial fishing on Lake Erie were purchased. Marketable harvest under these four licenses totaled 9,599 kilograms (21,163 lb) of yellow perch.

From 1987 to 1990, NYSDEC conducted a direct contact-sport fishing survey to monitor Lake Erie's open water fishery (New York State Department of Environmental Conservation 1991). The 1990 open water survey in the New York waters of Lake Erie showed 667,829 angler-hours in 118,269 trips. The total estimated harvests of walleye and yellow perch were 47,433 fish and 27,575 fish, respectively.

A creel/angler survey conducted by NYSDEC on Cattaraugus Creek in 1982 to assess the fall stream fishery for coho and chinook salmon indicated that catch rates for all species was very low and most fishermen were local residents (New York State Department of Environmental Conservation March 1983).

The Randolph New York Fish Hatchery, which is operated by NYSDEC, is located approximately 50 kilometers (30 mi) southwest of the West Valley site. It is used to raise brown trout primarily, with a lesser amount of brook trout and rainbow trout. The source of water for the raceways is a local natural spring, not

surface water. Trout from this hatchery are used to stock streams and rivers throughout the state of New York (Moradian 1994).

#### 4.3 Potential Ecological Receptors

The WVDP has recently completed an ecological information document wherein the terrestrial and aquatic ecosystems within the WNYNSC were identified. The following information, unless otherwise noted, was abstracted from this document (West Valley Nuclear Services Co., Inc. March 12, 1996d).

##### 4.3.1 Terrestrial Receptors

The WNYNSC site environs are within the Cattaraugus Highlands ecological subzone, which is a transitional zone between the Appalachian Plateau to the south and east and the Great Lakes Plain to the north and west. The generally acidic and poorly drained soils of the WNYNSC influence the occurrence, distribution, and relative abundance of the plant communities and their associated faunal species. Much of the plateau adjacent to stream drainages was cleared before 1961 for agricultural purposes and, later, for the WNYNSC facilities. As a result, the WNYNSC now consists of a mixture of abandoned agricultural areas in various stages of ecological succession, forested tracts, and wetlands, joined by transitional ecotones. Fifty-one small wetlands exist throughout the WNYNSC. They range in size from several hundred square feet to more than 9.2 acres and consist of wet meadows, emergent marshes and pond fringes, shrub swamps, and bogs and fens. The total wetland area is approximately 35 acres (Dames & Moore December 1993a).

The climax community forests at the WNYNSC are characterized by the dominance of sugar maple, beech, and eastern hemlock. At present, the site is about equally divided between forest land and abandoned farm fields. Plant communities found on-site have been categorized and generally are characteristic of western New York. The relatively undisturbed nature of large portions of the WNYNSC allowed for natural succession of previous agricultural areas within its boundaries. Because neither the setting nor the former agricultural land use are unique, the forest communities that will eventually develop in the abandoned fields will be common to the region.

A botanical survey of the WNYNSC conducted during 1991 and 1992 documented the presence of six New York State-listed rare, threatened, or endangered plant species and three unprotected species. The following list identifies the species and their status:

Rose Pink Pursh	NYS endangered
Round-leaved Bittercress	NYS rare
Small-flowered Agrimony	NYS rare
Houghtons sedge	NYS rare
Meadow Horse tail	NYS rare
Jack Pine	NYS rare
Few-fruited sedge	NYS unprotected
Rafinesque's Pondweed	NYS unprotected
Black-eyed Susan	NYS unprotected

An additional thirty-one species with New York State protection as exploitable vulnerable species were also found at the WNYNSC. No federally protected plant species were identified.

Because of the mixture of open areas and forested lands, terrestrial wildlife is abundant. Common resident game species found on-site and in the region include whitetail deer, Eastern cottontail, red fox, wild turkey, and ruffed grouse.

The WNYNSC is not on a normal migratory flyway nor is it extensively used as a normal resting area for migratory waterfowl. However, several such areas do exist nearby, including Lime Lake, 8 kilometers (5 mi) east; Farmersville Pond and Marsh, 16 kilometers (10 mi) east; and Cuba Lake and Marsh, 32 kilometers (20 mi) southeast. Based on population range maps, threatened or endangered species that could potentially occur at the WNYNSC include:

Birds:	Red-shouldered hawk - NYS threatened
	Northern harrier - NYS threatened
	Loggerhead shrike - NYS endangered
Mammals:	Indiana bat - federal and NYS endangered
Herptiles:	Eastern massasauga - NYS endangered
	Timber rattlesnake - NYS threatened

Historical records and field studies conducted through the end of 1991 did not identify or record any federally listed threatened or endangered wildlife species at the WNYNSC. Historic field investigations also did not identify any NYS-listed species; however, during the spring 1991 wildlife survey, one NYS-threatened species, the Northern harrier, was recorded on-site. This raptor prefers open wet meadow habitat for hunting. While some of the WNYNSC offers suitable habitat for this bird, similar and even better areas exist south (Beaver Meadows) and west (East Otto) of the site. In addition to the threatened and endangered lists, NYSDEC also maintains a list of species of "special concern," which includes species under consideration for inclusion as endangered or threatened species. Typically, species of "special concern" are those whose populations are declining, often in association with critical habitat loss. Of this list, eight birds, two mammals, and six herptiles may potentially occur at the WNYNSC. Recent field investigations have recorded seven of these species at the WNYNSC: common loon, northern raven, common nighthawk, henslow's sparrow, vesper sparrow, cooper's hawk, and eastern bluebird.

The U.S. Department of the Interior, Fish and Wildlife Service also maintains a file of specific habitat locations designated as critical to the survival of federally listed endangered or threatened species. A review of the most recent listings (1988) indicate that no such federal designations occur in or around the site. Critical habitat maps are also developed by NYSDEC's Bureau of Wildlife. In this instance, critical habitats are those areas found to be of significance to game and other important wildlife species and typically include wintering areas and breeding grounds. The WNYNSC is recognized by NYSDEC as a deer concentration area; however, this area is not unique in western New York. Other such areas have also been delineated within Cattaraugus and Allegany Counties. NYSDEC also recognizes a riparian area on Cattaraugus Creek as a critical habitat area. The delineated area reaches from Hake's Bridge on Cattaraugus Creek at Route 240 to the confluence with the south branch of Cattaraugus Creek.

#### 4.3.2 Aquatic Receptors

The aquatic environment at the WNYNSC consists of several creeks, two small reservoirs, and several beaver ponds. Recent field studies (1991) indicate that the WNYNSC has not produced any discernible effects on the

biotic composition of the streams in its drainage. Moreover, there is no indication from either historic records or the 1991 surveys that any threatened or endangered aquatic flora or fauna exist in the reservoirs, ponds, or streams on or in the vicinity of the WNYNSC. The only aquatic species on the New York State or federal lists that could potentially be influenced by the WNYNSC is the Eastern Sand Darter (*Ammocrypta pellucida*). NYSDEC historical records indicate occurrence of this fish in Cattaraugus Creek near Gowanda, New York. This area is downstream of the Buttermilk-Cattaraugus confluence but also downstream of the Springville Dam. Since the Eastern Sand Darter possesses no natural mode of transport to circumvent the dam, it is unlikely that it would ever be found in Cattaraugus Creek close to the WNYNSC. It is of note that the species of fish typically sought for human consumption (salmon, trout, walleye, and bass) were not identified in the aquatic environments on or directly adjacent to the site. This is consistent with the observation that these habitats are not suitable for the support of large populations of such fish.

RFI Volumes 2 through 10 provide discussions of SSWMU-specific information, including details of contamination characterization. Where appropriate, a discussion of SSWMU-specific contaminant pathways and contaminant receptors is included for those SSWMUs at which contamination has been detected.

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Table 1-1. List of Individual Solid Waste Management Units (SWMUs)

<u>SWMU #</u>	<u>Investigatory Status</u>	<u>Solid Waste Management Units</u>
1	1	Construction and Demolition Debris Landfill
2	1	NRC-licensed Disposal Area (NDA)
3	1	Lagoon 1
4	1	Active LLWTF Lagoons 2-5
5	1	Demineralizer Sludge Ponds
6	1	Solvent Dike
7	1	Effluent Mixing Basin
8	1	Maintenance Shop Sanitary Leach Field
9	1	Old Hardstand Storage Area
9a	1	New Hardstand Storage Area
10	1	Paper Waste Incinerator
11	1	Kerosene Tanks and NDA Container Storage
11a	1	Interim Waste Storage Facility
12	1	Vitrification Test Facility Waste Storage Tanks
12a	1	Tanks not used to store hazardous waste were taken out of service after vitrification cold testing; may be reused for other purposes
13	1	High-level Waste Tank Farm
14	1	Chemical Process Cell Waste Storage Area
15	1	Lag Storage Building
16	1	Lag Storage Extensions
16a	1	Lag Storage Additions
17	1	Low-level Waste Treatment Facility (LLWTF)
17a	1	Old and New Interceptors
17b	1	Neutralization Pit
18	1	Liquid Waste Treatment System (LWTS)

1 Investigated as part of this RFI

2<sup>a</sup> Require no further action as detailed in the RFI Work Plan

2<sup>b</sup> Require no further action. Preliminary assessments forwarded to NYSDEC for regulatory review.

3 Investigated as part of NYSERDA RFI

4 Requires further investigation. SWMU assessment plans have been developed.

5 Portions of roadways have been investigated as part of this RFI. Additional investigation may be necessary based upon results of this RFI.

Table 1-1. List of Individual Solid Waste Management Units (SWMUs) (concluded)

<u>SWMU #</u>	<u>Investigatory Status</u>	<u>Solid Waste Management Units</u>
19	1	Supernatant Treatment System (STS)
20	1	Vitrification Facility
21	2 <sup>a</sup>	Integrated Radwaste Treatment System (IRTS) Drum Cell
22	1	Cement Solidification System (CSS)
23	1	Trench Interceptor Project
24	2 <sup>a</sup>	Hazardous Waste Storage Lockers
-	3	New York State Licensed Disposal Area (SDA)
25	3	Inactive Scrap Material Landfill adjacent to Bulk Storage Warehouse (Outside Project premises and NYSEDA-managed)
<u>Newly Identified SWMUs</u>		
26	4	Subcontractor Maintenance Area
27	4	Fire Brigade Training Area
28	2 <sup>b</sup>	Vitrification Hardstand
29	2 <sup>b</sup>	Industrial Waste Storage Area
30	2 <sup>b</sup>	Cold Hardstand Area
31	1	NDA Trench Soil Container Area
32	2 <sup>b</sup>	Old Sewage Treatment Facility
33	2 <sup>b</sup>	Existing Sewage Treatment Facility
34	2 <sup>b</sup>	Temporary Storage Locations for Well Purge Water
35	2 <sup>b</sup>	Construction and Demolition Area
36	4	Old School House Septic System (outside of Project premises)
37	2 <sup>b</sup>	Contact Size-reduction Facility
38	1	Drum Super Compactor
39	1	Staging Area for NDA (brick wall)
40	2 <sup>b</sup>	Satellite Accumulation Areas and 90-Day Storage Areas
41	2 <sup>b</sup>	Warehouse Extension Waste Staging Area
42	4	Product Storage Area
43	5	Designated Site Roadways

1 Investigated as part of this RFI

2<sup>a</sup> Require no further action as detailed in the RFI Work Plan

2<sup>b</sup> Require no further action. Preliminary assessments forwarded to NYSDEC for regulatory review.

3 Investigated as part of NYSEDA RFI

4 Requires further investigation. SWMU assessment plans have been developed.

5 Portions of roadways have been investigated as part of this RFI. Additional investigation may be necessary based upon result this RFI.

Table 1-2. List of Super Solid Waste Management Units (SSWMUs) with Constituent SWMUs

<u>SSWMU #</u>	
1	<u>Low-Level Waste Treatment Facility (LLWTF)</u> Lagoon 1 (SWMU #3) Lagoons 2 and 3 (SWMU #4) Lagoons 4 and 5 (SWMU #4) Low-level Waste Treatment Facility (SWMU #17)
2	<u>Miscellaneous Small Units</u> Demineralizer Sludge Ponds (SWMU #5) Effluent Mixing Basin (SWMU #7) Solvent Dike (SWMU #6) Paper Waste Incinerator (SWMU #10)
3	<u>Liquid Waste Treatment System</u> Liquid Waste Treatment System (SWMU #18) Cement Solidification System (SWMU #22) Sealed Rooms
4	<u>High-level Waste Storage and Processing Area</u> High-level Waste Tanks (SWMU #13) Supernatant Treatment System (SWMU #19) Vitrification Facility (SWMU #20)
5	<u>Maintenance Shop Sanitary Leach Field</u> Maintenance Shop Sanitary Leach Field (SWMU #8)
6	<u>Low-level Waste Storage</u> Old Hardstand (SWMU #9) New Hardstand (SWMU #9a) Lag Storage Building (SWMU #15) Lag Storage Extensions 1 and 2 (SWMU #16) Lag Storage Additions 3 and 4 (SWMU #16a)
7	<u>Chemical Process Cell (CPC) Waste Storage Area</u> Chemical Process Cell (CPC) Waste Storage Area (SWMU #14)
8	<u>Construction and Demolition Debris Landfill</u> Construction and Demolition Debris Landfill
9	<u>NRC-licensed Disposal Area (NDA)</u> NRC-licensed Disposal Area (NDA) Kerosene Tanks (SWMU #11) Interim Waste Storage Facility (SWMU #11a) Trench Interceptor Project (SWMU #23) Staging Area for NDA (brick wall) (SWMU #39) NDA Trench Soil Container (SWMU #31)
10	<u>Integrated Radwaste Treatment System (IRTS) Drum Cell</u> Radwaste Treatment System (RTS) Drum Cell (SWMU #21)
11	<u>State-licensed Disposal Area (SDA)</u> Outside Project boundaries and managed by NYSEERDA
12	<u>Hazardous Waste Storage Lockers</u> Hazardous Waste Storage Lockers 1-4 (SWMU #24)

Table 2-1  
West Valley Demonstration Project Environmental Permits  
(as of January 12, 1995)

PERMIT NAME AND NUMBER	AGENCY/TYPE	DESCRIPTION	STATUS
Boilers (042200-0114-00002 and 042200-0114-00003)	NYSDEC - Certificate to Operate an Air Emission Source (CO)	Boilers located in the utility room	Renewal request was reviewed by NYSDEC and WVNS on 9/8/94. A new CO is forthcoming.
Cement storage silo ventilation system (042200-0114-CSS01)	NYSDEC - CO	Exhaust from the cement storage silo baghouse	Renewal request was reviewed by NYSDEC and WVNS on 9/8/94. A new CO is forthcoming.
Analytical & Process Chemistry Laboratory (042200-0114-15F-1)	NYSDEC - CO	Analytical & Process Chemistry Laboratory equipment from various laboratories in the process building	Renewal request was reviewed by NYSDEC and WVNS on 9/8/94. A new CO is forthcoming.
Tank #35157 vent (042200-0114-35157)	NYSDEC - CO	Vent from 3,000-gallon sulfuric acid tank #35157	Renewal request was reviewed by NYSDEC and WVNS on 9/8/94. A new CO is forthcoming.
Source-capture welding system (042200-0114-MS001)	NYSDEC - CO	Maintenance shop welding ventilation using "elephant trunk" ducts to vent welding fumes at the source of generation	Renewal request was reviewed by NYSDEC and WVNS on 9/8/94. A new CO is forthcoming.
Blueprint machine (042200-0114-00012)	NYSDEC - CO	Blueprint machine vent for ammonia emissions	Renewal request was reviewed by NYSDEC and WVNS on 9/8/94. A new CO is forthcoming.
Welding/painting and welding/painting blower exhaust (042200-0114-00013 through 042200-0114-00015)	NYSDEC - CO (three permits)	Portable blowers (some with and some without filters) for venting emissions from typical painting and welding operations in the vitrification facility	COs expire in 1998/1999. NYSDEC has agreed to extend these COs to allow WVDP to use these blowers for similar painting and welding operations anywhere on-site.
Analytical cell mock-up unit (042200-0114-00027)	NYSDEC - CO	Analytical cell mock-up unit (located in the vitrification test facility) emissions from use of laboratory chemicals	CO expires 12/1/98.

Table 2-1 (continued)

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West Valley Demonstration Project Environmental Permits  
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PERMIT NAME AND NUMBER	AGENCY/TYPE	DESCRIPTION	STATUS
Scale Vitrification System (SVS) solids transfer system (042200-0114-SVS01) SVS vessel vent system (042200-0114-SVS02) SVS mini-melter off-gas system (042200-0114-SVS04)	NYSDEC - CO (three permits)	Scale vitrification system vac-u-max solids transfer system vent, feed mix tank vent, and melter off-gas treatment system emissions.	COs issued 9/8/94 for one year (expiration 8/1/95). NYSDEC will reinspect upon test run start-up and will extend until 8/1/99.
Environmental Analytical Annex laboratory hoods (042200-0114-00016 through 042200-0114-00026)	NYSDEC - CO (eleven permits)	Eleven separate blowers for laboratory hoods and analytical equipment in the Environmental Analytical Annex. [aka., vitrification cold ops laboratory]	COs issued 8/11/94. Expire 8/1/99.
LLWTF nitric acid storage tank (042200-0114-00010)	NYSDEC - CO	Low-level waste treatment facility nitric acid storage tank #33013	NYSDEC acknowledged termination of CO on 9/19/94.
Tank #33154 Vent (042200-0114-33154)	NYSDEC - CO	3,200-gallon nitric acid tank #33154	NYSDEC acknowledged termination of CO on 9/19/94.
Tanks #14D-2 and 14D-2A (042200-0114-14D-2 and 042200-0114-14D-2A)	NYSDEC - CO (two permits)	Sodium hydroxide tanks 14D-2 and 14D-2A	NYSDEC acknowledged termination of CO on 9/19/94.
Nitric acid tank vent (042200-0114-MDB07)	NYSDEC - CO	250-gallon nitric acid tank used in the melter disassembly building	NYSDEC acknowledged termination of CO on 9/19/94.
Cold chemical solids transfer system (042200-0114-CTS02) Cold chemical vessel vent system (042200-0114-CTS03) Cold chemical vessel dust collection hood (042200-0114-CTS04)	NYSDEC - Permits to Construct an Air Emission source (PC) (three permits)	Cold chemical facility. Dry or solid chemical emissions from solids transfer system, dust collection hood, and from mix tank vent for vitrification operations.	PCs expired on 12/31/94. NYSDEC indicated that a one-year extension has been approved and the revised PC is forthcoming. Will convert to COs as soon as construction is completed.
SVS ammonia vent system (emission point SVS07)	NYSDEC - PC	Scale vitrification system ammonia vent system for relieving pressure before cylinder change-outs.	NYSDEC issued CO on 10/11/94. Expires 8/1/99.
Vitrification off-gas treatment system (042200-0114-15F-1)	NYSDEC - PC	Vitrification facility off-gas treatment system emissions.	PC expires on 7/31/95. Will be converted to a CO when construction and turnover are completed.

Table 2-1 (continued)

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West Valley Demonstration Project Environmental Permits  
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PERMIT NAME AND NUMBER	AGENCY/TYPE	DESCRIPTION	STATUS
Vitrification facility Heating, Ventilating, and Air Conditioning (HVAC) System (042200-0114-15F-2)	NYSDEC - PC	Canister welding emissions vented through vitrification facility HVAC system. [i.e., canister welding ventilation]	PC expired on 1/1/95. NYSDEC indicated that a one-year extension has been approved and the revised PC is forthcoming. Will convert to CO when construction and turnover are complete.
Slurry-Fed Ceramic Melter (SFCM)	EPA. Applied for NESHAPs Permit	Slurry-fed ceramic melter radionuclides emissions	Submitted 9/93. Required by 1/96. EPA has reviewed and indicated that the permit should be issued around 1/31/95. Awaiting response.
Vitrification HVAC system	EPA. Applied for NESHAPs Permit	Vitrification facility HVAC system radionuclide emissions	Submitted 9/93. Required by 1/96. EPA has reviewed and indicated that the permit should be issued around 1/31/95. Awaiting response.
01-14 building ventilation system (WVDP-187-01)	EPA. NESHAPs	LWTS ventilation of radionuclides in the 01-14 building	Issued 10/5/87. Modified 5/25/89. No expiration date.
Contact Size Reduction Facility (CSRF) (WVDP-287-01)	EPA. NESHAPs	CSRF radionuclide emissions	Issued 10/5/87. No expiration date.
STS (WVDP-387-01)	EPA. NESHAPs	Supernatant treatment system ventilation for radionuclide emissions	Issued 10/5/87. No expiration date.
LLW Supercompactor (WVDP-487-01)	EPA. NESHAPs	LLW supercompactor ventilation system for radionuclide emissions	Issued 10/5/87. No expiration date.
Outdoor ventilation system (WVDP-587-01)	EPA. NESHAPs	Ten portable ventilation units for removal of radionuclides	Issued 12/22/87. No expiration date.
Process building ventilation system (WVDP-687-01)	EPA. NESHAPs	Original process building ventilation of radionuclides	Issued 12/22/87. No expiration date.
RCRA Part A	NYSDEC - Hazardous waste	Waste management for WVDP - process HLW, container storage of mixed waste, identifies waste streams and RCRA limits	Currently operating under interim status.
SPDES NY0000973	NYSDEC - water discharge	Covers discharges to surface waters from various sources on-site	Expires 2/1/99. Currently undertaking flow augmentation project for total dissolved solids (TDS) control. To be implemented by 4/95.

Table 2-1 (concluded)

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PERMIT NAME AND NUMBER	AGENCY/TYPE	DESCRIPTION	STATUS
NO <sub>x</sub> protocol	NYSDEC - NO <sub>x</sub> monitoring protocol	NO <sub>x</sub> monitoring protocol (plan) must be approved by NYSDEC.	Received NYSDEC comments on 9/16/94. Revised protocol to address NYSDEC comments will be forwarded on 1/95. Required by 9/95.
Chemical Bulk Storage (CBS)	NYSDEC - CBS storage tank registration	Registration of bulk storage tanks used for listed hazardous chemicals.	Expires 7/95. Will renew before expiration.
Petroleum Bulk Storage (PBS)	NYSDEC - PBS tank registration	Registration of bulk storage tanks used for petroleum.	Expires 9/96. Will renew before expiration.
Depredation permit PRT-747595	U.S. Fish & Wildlife Service/New York State Division of Fish & Wildlife	License for the removal of migratory bird nests	Annual license and report. Revising to incorporate additional species and to obtain more usable conditions. Expires 5/2/95.

Table 3-1

Regional Bedrock Sequence  
(page 1 of 5)

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System	Group	Formation	Description
Pennsylvanian	Pottsville	Connoquenessing	Thick-bedded, hard, brown or white sandstones, dark gray arenaceous shales.
		Sharon	Dark arenaceous shales, thin coal, thick-bedded pebbly sandstones, conglomerates.
		Olean Conglomerate	Thick-bedded, round-quartz-pebble conglomerate.
Mississippian	Pocono	Cuyahoga	Olive shales, thin-bedded sandstones.
		Corry Sandstone	Grayish-white pure fine sandstone.
		Sandstone	Gray shales, fine flat-pebble conglomerates.
Devonian	Conewango	Oswayo	Olive green to rusty-colored arenaceous shales, thin sandstones.
		Venango	Gray arenaceous shales, fine-grained sandstones; both replaced eastwardly by Cattaraugus Formation - red and gray shales, cross-bedded flaggy green sandstones, thin flat-pebble conglomerates.
	Conneaut	Ellicott and Dexterville	Gray shales and siltstones; both replaced eastwardly by Cattaraugus Formation - red and gray shales, cross-bedded flaggy green sandstones, thin flat-pebble conglomerates.
	Canadaway (as defined east of 79°00' longitude)	Machias	Gray shales and siltstones.
		Rushford Sandstone	Gray siltstones, sandstones, and shales.
		Canadea and Canisteo Shales	Gray silty shales and siltstones.
		Hume Shale	Grayish-black shales.
		Canaseraga Sandstone	Thin- to thick-bedded siltstones and sandstones, interbedded gray shales.
		South Wales Shale	Dark gray shales and siltstones, calcareous concretions.
		Dunkirk Shale	Fissile black shales.

Table 3-1

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Regional Bedrock Sequence  
(page 2 of 5)

System	Group	Formation	Description
Devonian (continued)	Java	Hanover Shale	Gray calcareous shales and blocky mudstones, abundant calcareous nodules and concretions; replaced eastwardly by Wiscoy Formation - gray clayey siltstones, silty mudstones, and fine sandstones.
		Pipe Creek Shale	Black, grayish-black, and brownish-black shales.
	West Falls	Angola Shale	Gray shales and mudstones; abundant calcareous nodules and concretions, fissile grayish-black, and brownish-black shales; replaced eastwardly by Nunda Formation - bluish gray thin- to thick-bedded siltstones, gray silty mudstones and shales, calcareous siltstone concretions.
		Rhinestreet Shale	Brownish-black and black petroliferous shales, gray shales, thin calcareous siltstones.
	Soyea	Cashaqua Shale	Bluish-gray.
		Middlesex Shale	Fissile black shales, dark gray shales, and thin siltstones.
	Genesee	West River Shale	Interbedded dark gray and fissile black shales.
		Genundewa Limestone	Brownish-gray lenticular, nodular, and concretionary limestones, mainly argillaceous.
		Penn Yan Shale	Gray silty shales and interbedded gray siltstones, thin black shales, few nodular calcareous siltstones and limestones.
		Genesee Shale	Fissile black and brownish black petroliferous shales, thin nodular limestones, concretions, and septaria.

Table 3-1

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Regional Bedrock Sequence  
(page 3 of 5)

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System	Group	Formation	Description
Devonian (continued)	Hamilton	Moscow	Gray shales and thin interbedded limestones, blue-gray shales and calcareous concretions, coarse crinoidal limestone.
		Ludlowville	Bluish-gray shales, gray limestones and calcareous shales; gray-black fissile shales and thin limestones, dense crystalline limestone.
		Skaneateles	Levanna black and gray shales, thin limestones; Stafford dark gray limestone.
		Marcellus	Oatka calcareous fissile black shales.
	Onondaga Limestone	Onondaga Limestone	Seneca dark gray limestone and chert, Tioga Bentonite, Morehouse thick-bedded medium gray calcilutite and chert; Clarence chert in Western New York.
		Oriskany Sandstone	Calcareous quartz sandstone, siliceous limestone.
Silurian	Akron Dolostone and Salina	Akron Dolostone	Light gray laminated, banded and mottled argillaceous dolostones, dolomitic limestones.
		Camillus Shale	Soft green dolomitic shales, gypsiferous shales.
		Syracuse	Light gray argillaceous dolostones, clay, green dolomitic shales, gypsum (salt and anhydrite in subsurface).
		Vernon	Gray argillaceous dolostones and green dolomitic shale, gypsum; replaced eastwardly by thick-bedded red and green mudstones.
	Lockport	Oak Orchard Dolostone	Gray, bituminous, with local bioherms.
		Eramosa Dolostone	Gray, argillaceous.
		Goat Island Dolostone	Gray, argillaceous.
		Gasport Limestone	Gray calcarenite, local crinoidal bioherms.
	Clinton	Decew Dolostone, Rochester Shale	Calcareous gray shales, thin limestones.

Table 3-1

Regional Bedrock Sequence  
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System	Group	Formation	Description
Silurian (continued)	Medina	Thorold Sandstone	Gray to white, fine-grained.
		Grimsby	Red, green, gray, and mottled sandstones; red shales.
		Power Glen and Cabot Head Shales	Greenish-gray, with interbedded thin gray to white siltstones.
		Whirlpool Sandstone	White.
Ordovician	Queenston	Queenston	Red siltstones, red shales with rare green patches.
	Lorraine	Oswego Sandstone	Pink to gray with thin red or green siltstone, shales.
		Pulaski	Tan and gray siltstones, shales; light gray sandstones.
		Utica Shale	Fissile black calcareous shales.
	Trenton	In Black River Valley:	Limestones thin to medium-bedded argillaceous calcilutites, calcarenites, calcisiltites, locally cherty; calcareous shales.
		In western New York:	Undifferentiated.
	Black River	In Black River Valley:	Limestone - cherty, thick-bedded gray-black calcilutite; light gray thick- to thin-bedded calcilutite; greenish gray argillaceous dolostone, feldspathic sandstone at base.
		In western New York:	Undifferentiated.
	Beekmantown	In Mohawk Valley:	
		Chuctanunda Creek Dolostone	Gray dolostones, locally cherty.
		Tribes Hill	Glauconitic and oolitic calcarenites and calcitic dolostones; black, thick-bedded, dolomitic calcilutite and gray dolostones; gray, thin-bedded, dolomitic limestones with interbedded shales; calcitic dolostones.
		In western New York:	Undifferentiated.

Table 3-1

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Regional Bedrock Sequence  
(page 5 of 5)

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System	Group	Formation	Description
Cambrian	Saratoga Springs	Little Falls Dolostone	Medium- to thick-bedded, cherty, oolitic, fine- to medium-grained, cream to light gray dolostones.
		Theresa	Gray, coarse-grained dolostones, dolomitic sandstones.
		Potsdam Sandstone	Upper portion relatively pure cream to white quartzitic sandstones; middle portion pink to gray feldspathic sandstones, thin local quartz pebble lenses and shale interbeds; lower portion maroon, red, and green shales, maroon argillaceous hematitic sandstones, and pebble to boulder conglomerates.
Precambrian Basement			

Table 3-2

History of Drilling at the Western New York Nuclear Service Center  
(page 1 of 2)

Borehole Designation	Date Drilled	Location	References
Oil and Gas Holes	Pre-1963	Whole site	
Domestic Wells	Pre-1963	Whole site	
PAH-n,DH-n	1961-1962	Whole site	Stewart 1962a, 1962b; Dames & Moore 1971a
1-25	1963	Security area, process building	Dames & Moore 1963a
1, 1A, 2, 2c, 3, 4	1963	Water supply reservoir south of security area	
Ch-1 and four others	1967-1969	East of security area	de Laguna 1972; Sun and Mongan 1974; Sun 1982
26, 27	1970	Security area, process building	Dames & Moore 1970b
28-32	1971	Security area, process building	Dames & Moore 1971b
33-43	1974	Security area	Dames & Moore 1975
1-9	1970	Near plutonium storage area	Dames & Moore 1970a
1-13, 2A-D, 9A-D	1973-1974	Perimeter of SDA-NDA	Davis 1974; Duckworth et al. 1974; Giardina et al. 1977; Bailey 1975
B-1 thru B-7 TP-1 thru TP-7	1974	Erdman Brook valley	Dames & Moore 1974
B1 thru B5	1975	South and west of security area	
A-Z, HA-n	1975-1980	Around SDA	Prudic and Randall 1977
n-na	1976-1977	Into trenches at SDA	Dana et al. 1980
80-1 thru 80-10	1980	Security area	Albanese et al. 1982
A82-1-2	1982	East of SDA	Albanese et al. 1983
82-1 thru 82-5	1982	Perimeter NDA	Albanese et al. 1984
83-1 thru 83-3	1983	West of NDA	Albanese et al. 1984

Table 3-2

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History of Drilling at the WNYNSE  
(page 2 of 2)

Borehole Designation	Date Drilled	Location	References
83-4E	1983	North plateau	Albanese et al. 1984
DM 83-01 thru EM 83-06	1983	Process Building	Dames & Moore 1983 a&b
B-84-01 thru B-84-12	1984	NDA	West Valley Nuclear Services Co., Inc. 1985b
B-1 thru B-4; B-8	1985	Process Building	Dames & Moore 1985a
B-85-50-n, 7 wells; B-01-86 thru B-06-86	1985	Process Building	Dames & Moore 1985b
B-86-01 thru B-86-13; B-86-14 thru B-86-20	1986	Process Building	Dames & Moore 1986
B-88-01 thru B-88-05	1988	Process Building	Dames & Moore 1988
B-89-01 thru B-89-04	1989	Process Building	Dames & Moore 1990
20 Boreholes	1989	NDA	Dames & Moore 1992a
96 wells at 58 locations	1989-1990	NDA, SDA, north plateau	Dames & Moore 1992c
24 wells	1991	SDA	Dames & Moore 1993b
HLW-1 to HLW-6	1991	HLW Tank Farm	Dames & Moore 1992b
STP-1 to STP-4	1991	Sewage Treatment Plant	Dames & Moore 1991

Table 3-3

WVDP Hydraulic Conductivity Data (cm/sec) from the Surficial Sand and Gravel Unit

<u>Well</u>	<u>BR Rise</u>	<u>BR Fall</u>	<u>Rising and Falling Head Average</u>
0103	3.95E-05	1.37E-05	2.66E-05
0106	1.05E-04	2.09E-04	1.57E-04
0116	2.62E-05	1.45E-05	2.04E-05
0201	3.36E-04	2.45E-03	1.39E-03
0203	1.11E-03		1.11E-03
0205	2.28E-03	2.85E-03	2.57E-03
0301		6.05E-05	6.05E-05
0305	1.16E-04	1.73E-05	6.67E-05
0307	8.76E-06	3.14E-05	2.01E-05
0403	3.17E-05	1.57E-04	9.44E-05
0406	5.26E-05	6.09E-05	5.68E-05
0602		1.57E-04	1.57E-04
0603	7.84E-05	1.08E-04	9.32E-05
0604	6.53E-04	6.65E-04	6.59E-04
0801	4.22E-04	1.68E-04	2.95E-04
0803	4.42E-04	6.59E-04	5.51E-04
80USGS-2	1.10E-04	4.82E-05	7.91E-05
80USGS-3		1.30E-04	1.30E-04
=====			
Mean	3.87E-04	4.79E-04	4.19E-04

Rise indicates rising head slug test  
 Fall indicates falling head slug test

BR = Bouwer and Rice Method (1976)

Table 3-4

Buffalo National Weather Service Station Average Monthly  
Wind Speeds and Maximum Recorded Speeds and Directions (30 yr)  
(mph)

	<u>JAN.</u>	<u>FEB.</u>	<u>MAR.</u>	<u>APR.</u>	<u>MAY</u>	<u>JUNE</u>	<u>JULY</u>	<u>AUG.</u>	<u>SEPT.</u>	<u>OCT.</u>	<u>NOV.</u>	<u>DEC.</u>	<u>ANNUAL AVERAGE</u>
Average Monthly Wind Speed	14.5	14.0	13.7	13.0	11.7	11.2	10.5	10.0	10.6	11.4	12.9	13.5	12.3
Prevailing Direction	WSW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	WSW	SW
Highest Recorded Velocity	91	70	68	67	63	56	59	56	59	63	66	60	
Direction	SW	SW	W	W	SW	NW	NW	SW	SW	SW	SW	S	

S - south

SW - southwest

W - west

NW - north west

mph - miles per hour

Table 3-5

## Comparison of On-site and Buffalo Monthly Averages of Meteorological Data (1984-1989)

## 1984 MONTHLY AVERAGES

	WVDP 10M WS (mps)	WVDP 60M WS (mps)	WVDP REGN WS (mps)	BUFFALO WS (mps)	WVDP 10M WD (deg)	WVDP 60M WD (deg)	WVDP REGN WD (deg)	BUFFALO WD (deg)
JAN	2.5	4.3	4.8	4.9	247.	256.	261.	238.
FEB	2.9	4.7	5.1	4.8	240.	249.	252.	218.
MAR	3.2	4.9	5.3	5.0	213.	246.	268.	353.
APR	2.9	4.3	4.5	4.2	179.	188.	212.	137.
MAY	2.7	4.5	4.7	4.9	252.	262.	268.	229.
JUN	2.3	4.0	4.0	4.2	224.	242.	256.	218.
JUL	2.0	3.5	3.4	4.0	232.	246.	262.	225.
AUG	1.8	3.0	2.9	3.3	237.	252.	264.	225.
SEP	2.1	3.5	3.7	3.5	205.	217.	243.	219.
OCT	2.0	3.2	3.7	3.3	206.	203.	218.	137.
NOV	3.0	5.1	5.3	4.9	238.	250.	260.	237.
DEC	3.0	5.1	5.8	5.5	234.	241.	249.	237.

## 1985 MONTHLY AVERAGES

	WVDP 10M WS (mps)	WVDP 60M WS (mps)	WVDP REGN WS (mps)	BUFFALO WS (mps)	WVDP 10M WD (deg)	WVDP 60M WD (deg)	WVDP REGN WD (deg)	BUFFALO WD (deg)
JAN	2.9	5.1	5.6	5.8	260.	266.	269.	258.
FEB	3.1	5.1	5.4	5.6	247.	254.	257.	231.
MAR	3.4	5.5	5.8	5.4	255.	263.	268.	244.
APR	2.8	4.7	4.8	4.9	251.	259.	265.	234.
MAY	2.5	3.9	5.2	4.4	225.	225.	269.	217.
JUN	2.3	4.0	6.0	4.3	249.	266.	266.	246.
JUL	2.1	3.6	3.7	4.1	216.	234.	251.	222.
AUG	2.0	3.5	3.3	3.7	204.	212.	244.	198.
SEP	2.0	3.5	3.5	3.8	215.	232.	255.	212.
OCT	2.6	4.4	4.6	4.1	196.	204.	218.	196.
NOV	3.2	5.0	5.5	4.4	174.	191.	209.	68.
DEC	2.9	5.1	5.5	5.5	237.	247.	255.	245.

WS - Wind speed      10M - 10 meter monitoring level  
WD - Wind direction      60M - 60 meter monitoring level  
MPS - Meters per second      REGN - Regional tower  
deg - wind direction azimuth

Table 3-5 (continued)

## Comparison of On-site and Buffalo Monthly Averages of Meteorological Data (1984-1989)

## 1986 MONTHLY AVERAGES

	WVDP 10M WS (mps)	WVDP 60M WS (mps)	WVDP REGN WS (mps)	BUFFALO WS (mps)	WVDP 10M WD (deg)	WVDP 60M WD (deg)	WVDP REGN WD (deg)	BUFFALO WD (deg)
JAN	3.1	5.3	5.5	5.6	257.	260.	264.	246.
FEB	2.7	4.1	4.4	4.7	265.	260.	265.	279.
MAR	3.0	5.0	5.1	5.6	244.	252.	259.	234.
APR	2.7	4.3	4.3	4.6	245.	250.	277.	207.
MAY	2.5	4.2	4.3	4.5	235.	246.	260.	220.
JUN	2.4	4.0	3.9	3.8	242.	258.	249.	243.
JUL	2.0	3.4	3.3	3.5	248.	259.	269.	243.
AUG	2.1	3.7	3.7	3.8	215.	229.	250.	217.
SEP	2.4	4.2	4.3	3.8	200.	214.	236.	198.
OCT	2.4	4.0	4.3	4.0	212.	228.	252.	216.
NOV	2.8	4.5	4.9	4.2	231.	242.	254.	241.
DEC	2.7	4.4	5.0	4.9	243.	247.	258.	250.

## 1987 MONTHLY AVERAGES

	WVDP 10M WS (mps)	WVDP 60M WS (mps)	WVDP REGN WS (mps)	BUFFALO WS (mps)	WVDP 10M WD (deg)	WVDP 60M WD (deg)	WVDP REGN WD (deg)	BUFFALO WD (deg)
JAN	2.7	4.6	5.0	4.6	251.	256.	272.	249.
FEB	2.4	3.9	4.4	4.0	259.	281.	308.	293.
MAR	2.6	4.1	4.5	4.0	193.	253.	306.	323.
APR	3.0	4.6	4.9	4.4	133.	141.	128.	90.
MAY	2.6	4.1	4.2	4.3	211.	240.	250.	221.
JUN	2.0	3.4	3.5	4.0	224.	239.	262.	228.
JUL	1.9	3.3	3.4	3.2	226.	250.	261.	223.
AUG	2.0	3.6	3.7	3.8	198.	218.	239.	212.
SEP	1.9	3.3	3.4	3.2	200.	222.	236.	201.
OCT	2.3	4.0	4.4	4.0	226.	239.	255.	234.
NOV	3.3	5.3	5.6	4.7	227.	239.	251.	242.
DEC	3.1	4.9	5.4	5.3	258.	260.	267.	255.

WS - Wind speed      10M - 10 meter monitoring level  
WD - Wind direction      60M - 60 meter monitoring level  
MPS - Meters per second      REGN - Regional tower  
deg - wind direction azimuth

Table 3-5 (concluded)

## Comparison of On-site and Buffalo Monthly Averages of Meteorological Data (1984-1989)

## 1988 MONTHLY AVERAGES

	WVDP 10M WS (mps)	WVDP 60M WS (mps)	WVDP REGN WS (mps)	BUFFALO WS (mps)	WVDP 10M WD (deg)	WVDP 60M WD (deg)	WVDP REGN WD (deg)	BUFFALO WD (deg)
JAN	2.9	5.0	5.6	5.6	222.	236.	250.	229.
FEB	3.0	5.0	5.5	5.8	258.	258.	265.	235.
MAR	2.7	4.5	4.9	5.0	267.	265.	276.	243.
APR	2.9	4.7	4.4	4.7	283.	278.	292.	254.
MAY	2.2	3.5	3.9	3.9	192.	214.	275.	204.
JUN	2.1	3.7	3.6	4.4	283.	288.	308.	266.
JUL	1.8	3.1	3.0	3.7	230.	254.	278.	224.
AUG	2.0	3.5	3.5	3.9	208.	227.	249.	207.
SEP	2.1	3.7	4.0	4.0	204.	223.	243.	218.
OCT	2.6	4.5	4.6	4.5	234.	243.	257.	220.
NOV	3.3	5.2	5.6	5.1	218.	226.	240.	211.
DEC	2.9	4.9	5.4	5.7	246.	256.	262.	244.

## 1989 MONTHLY AVERAGES

	WVDP 10M WS (mps)	WVDP 60M WS (mps)	WVDP REGN WS (mps)	BUFFALO WS (mps)	WVDP 10M WD (deg)	WVDP 60M WD (deg)	WVDP REGN WD (deg)	BUFFALO WD (deg)
JAN	3.4	5.5	6.2	5.9	229.	241.	249.	225.
FEB	2.6	4.1	4.6	4.5	266.	270.	280.	252.
MAR	2.9	4.3	4.7	4.0	209.	211.	231.	71.
APR	2.4	3.8	4.0	3.9	266.	271.	283.	238.
MAY	2.3	4.1	4.2	3.9	223.	235.	250.	215.
JUN	2.0	3.3	3.1	3.4	230.	225.	258.	213.
JUL	1.7	2.8	2.8	3.0	200.	199.	265.	203.
AUG	1.9	3.4	3.4	3.7	229.	236.	256.	216.
SEP	2.1	3.6	3.7	3.2	188.	184.	209.	137.
OCT	2.5	4.3	4.3	4.2	222.	238.	252.	213.
NOV	3.2	5.5	6.0	5.8	236.	246.	254.	238.
DEC	2.2	3.9	4.3	4.4	230.	243.	253.	233.

WS - Wind speed      10M - 10 meter monitoring level  
WD - Wind direction      60M - 60 meter monitoring level  
MPS - Meters per second      REGN - Regional tower  
deg - wind direction azimuth

Table 3-6

Comparison of Monthly Wind Speed Maximums for the West Valley Demonstration Project and Buffalo

1984 MONTHLY MAXIMUMS

	WVDP 10M (mps)	WVDP 60M (mps)	WVDP REGN (mps)	BUFFALO (mps)
JAN	9.1	11.6	11.1	14.8
FEB	9.6	12.4	10.8	12.5
MAR	11.9	14.9	12.1	14.8
APR	8.8	11.4	11.5	17.9
MAY	10.4	12.6	13.0	14.8
JUN	6.1	9.0	8.6	11.2
JUL	5.4	8.5	7.7	10.7
AUG	4.6	7.2	6.5	8.9
SEP	5.8	9.1	9.1	12.1
OCT	5.8	8.9	9.3	13.0
NOV	10.8	14.6	11.7	13.4
DEC	9.5	11.8	11.1	13.4

1985 MONTHLY MAXIMUMS

	WVDP 10M (mps)	WVDP 60M (mps)	WVDP REGN (mps)	BUFFALO (mps)
JAN	6.8	11.3	11.8	17.9
FEB	12.4	16.5	13.8	13.4
MAR	10.6	13.1	12.9	16.1
APR	8.8	13.5	11.8	17.9
MAY	6.2	8.9	13.4	12.1
JUN	7.1	13.4	12.1	12.5
JUL	8.9	15.0	8.6	11.6
AUG	6.0	12.1	8.1	11.6
SEP	8.0	11.3	12.5	10.7
OCT	7.3	10.2	25.0	11.6
NOV	9.2	12.5	11.2	13.9
DEC	10.8	14.5	12.5	17.0

MPS - Meters per second      REGN - Regional tower  
10M - 10 meter monitoring level  
60M - 60 meter monitoring level

Table 3-6 (continued)

## Comparison of Monthly Wind Speed Maximums for the WVDP and Buffalo

## 1986 MONTHLY MAXIMUMS

	WVDP 10M (mps)	WVDP 60M (mps)	WVDP REGN (mps)	BUFFALO (mps)
JAN	11.1	12.8	12.0	14.3
FEB	10.0	11.2	11.7	12.5
MAR	9.8	12.4	12.0	18.8
APR	8.5	9.8	9.0	10.7
MAY	8.5	10.4	10.8	11.6
JUN	7.0	9.4	9.6	12.1
JUL	6.8	9.3	10.6	10.7
AUG	7.8	9.9	8.9	11.6
SEP	7.9	10.0	9.7	11.2
OCT	6.7	10.0	10.6	13.0
NOV	9.0	11.4	11.1	17.9
DEC	9.5	10.3	10.4	11.6

## 1987 MONTHLY MAXIMUMS

	WVDP 10M (mps)	WVDP 60M (mps)	WVDP REGN (mps)	BUFFALO (mps)
JAN	8.7	10.6	12.9	12.1
FEB	9.1	11.6	12.0	11.2
MAR	9.9	12.6	11.1	11.6
APR	12.6	13.2	14.1	12.1
MAY	6.8	8.5	9.0	11.2
JUN	6.8	8.4	9.5	12.1
JUL	4.8	8.5	7.1	8.0
AUG	5.2	8.5	8.8	10.3
SEP	6.1	8.6	8.2	10.7
OCT	7.2	9.6	11.3	9.8
NOV	10.6	14.3	11.1	12.1
DEC	14.2	15.8	12.9	15.2

MPS - Meters per second      REGN - Regional tower  
 10M - 10 meter monitoring level  
 60M - 60 meter monitoring level

Table 3-6 (concluded)  
Comparison of Monthly Wind Speed Maximums for the WVDP and Buffalo

1988 MONTHLY MAXIMUMS

	WVDP 10M (mps)	WVDP 60M (mps)	WVDP REGN (mps)	BUFFALO (mps)
JAN	11.1	13.7	12.5	14.8
FEB	11.5	12.4	13.4	15.6
MAR	7.9	10.3	10.4	13.9
APR	7.4	9.6	11.1	14.8
MAY	7.9	9.7	9.7	10.3
JUN	7.0	10.4	9.2	13.4
JUL	5.0	8.3	7.3	10.3
AUG	7.2	10.3	9.0	11.6
SEP	7.7	9.2	10.2	10.7
OCT	7.6	10.6	12.5	13.0
NOV	11.7	14.1	11.5	15.6
DEC	11.3	13.9	12.1	15.6

1989 MONTHLY MAXIMUMS

	WVDP 10M (mps)	WVDP 60M (mps)	WVDP REGN (mps)	BUFFALO (mps)
JAN	9.7	13.0	13.4	18.8
FEB	9.1	11.4	11.2	14.3
MAR	9.9	12.9	11.6	14.3
APR	6.3	9.1	9.2	11.2
MAY	7.6	10.3	10.0	10.3
JUN	6.4	8.0	7.4	10.7
JUL	5.3	8.1	9.1	12.5
AUG	5.1	9.2	9.3	11.2
SEP	6.9	9.2	8.9	11.2
OCT	6.8	9.6	9.5	11.6
NOV	10.6	15.0	13.3	16.5
DEC	7.5	10.8	10.8	12.5

MPS - Meters per second      REGN - Regional tower  
10M - 10 meter monitoring level  
60M - 60 meter monitoring level

Table 3-7

WVDP and Buffalo Monthly Average Temperatures (1984-1989)

1984 MONTHLY AVERAGES			1986 MONTHLY AVERAGES			1988 MONTHLY AVERAGES		
	WVDP 10M (°C)	BUFFALO (°C)		WVDP 10M (°C)	BUFFALO (°C)		WVDP 10M (°C)	BUFFALO (°C)
JAN	-7.9	-6.1	JAN	-4.0	-3.6	JAN	-5.0	-2.9
FEB	-4.5	-3.8	FEB	-4.7	-4.3	FEB	-5.4	-4.0
MAR	.9	1.7	MAR	2.2	2.4	MAR	.4	1.5
APR	9.3	9.5	APR	8.0	8.8	APR	5.3	7.3
MAY	13.8	15.5	MAY	14.2	15.2	MAY	13.3	15.3
JUN	14.9	16.9	JUN	16.9	18.0	JUN	16.0	18.2
JUL	18.8	21.1	JUL	19.7	21.6	JUL	21.0	23.6
AUG	18.4	20.7	AUG	17.1	19.8	AUG	19.8	22.5
SEP	15.9	17.8	SEP	16.0	16.6	SEP	14.3	16.9
OCT	10.1	11.5	OCT	9.2	10.5	OCT	6.2	8.0
NOV	5.2	5.3	NOV	2.2	3.3	NOV	4.7	6.0
DEC	-4.9	-3.7	DEC	-1.2	0.2	DEC	-2.8	-1.2

1985 MONTHLY AVERAGES			1987 MONTHLY AVERAGES			1989 MONTHLY AVERAGES		
	WVDP 10M (°C)	BUFFALO (°C)		WVDP 10M (°C)	BUFFALO (°C)		WVDP 10M (°C)	BUFFALO (°C)
JAN	-7.4	-6.3	JAN	-5.0	-3.3	JAN	-1.6	-.4
FEB	-.2	.9	FEB	-5.4	-3.8	FEB	-6.1	-5.0
MAR	-3.9	-2.6	MAR	1.7	3.0	MAR	.2	.2
APR	7.0	8.7	APR	8.3	9.8	APR	4.8	5.3
MAY	10.3	11.5	MAY	14.3	15.7	MAY	11.8	12.5
JUN	18.2	20.0	JUN	18.2	20.6	JUN	17.4	18.7
JUL	18.7	21.6	JUL	21.0	23.3	JUL	19.6	21.9
AUG	19.5	21.2	AUG	18.1	20.5	AUG	18.2	20.2
SEP	13.6	14.8	SEP	15.3	17.1	SEP	14.7	16.0
OCT	11.9	11.7	OCT	6.7	8.6	OCT	9.6	10.6
NOV	2.9	3.9	NOV	4.6	5.8	NOV	2.3	3.5
DEC	1.2	2.0	DEC	-.5	1.2	DEC	-9.1	-8.0

10M - 10 meter monitoring level

Table 3-8

## WVDP and Buffalo Maximum Wind Speeds and Temperatures (1984-1989)

1984 MONTHLY MAXIMUMS						
	WVDP 10M (°C)	BUFFALO (°C)	WVDP 10M (mps)	WVDP 60M (mps)	WVDP REGN (mps)	BUFFALO (mps)
JAN	5.0	5.0	9.1	11.6	11.1	14.8
FEB	15.7	16.7	9.6	12.4	10.8	12.5
MAR	16.2	13.3	11.9	14.9	12.1	10.8
APR	25.5	28.9	8.8	11.4	11.5	17.9
MAY	28.1	28.3	10.4	12.6	13.0	14.8
JUN	29.5	31.7	6.1	9.0	8.6	11.2
JUL	28.6	31.1	5.4	8.5	7.7	10.7
AUG	29.5	30.6	4.6	7.2	6.5	8.9
SEP	26.1	27.8	5.8	9.1	9.1	12.1
OCT	26.4	23.9	5.8	8.9	9.3	13.0
NOV	17.6	20.6	10.8	14.6	11.7	13.4
DEC	15.7	17.8	9.5	11.8	11.1	13.4

1985 MONTHLY MAXIMUMS						
	WVDP 10M (°C)	BUFFALO (°C)	WVDP 10M (mps)	WVDP 60M (mps)	WVDP REGN (mps)	BUFFALO (mps)
JAN	15.2	17.2	6.8	11.3	11.8	17.9
FEB	14.1	13.9	12.4	16.5	13.8	13.4
MAR	20.5	21.1	10.6	13.1	12.9	16.1
APR	28.4	31.1	8.8	13.5	11.8	17.9
MAY	26.4	28.3	6.2	8.9	13.4	12.1
JUN	29.1	28.3	7.1	13.4	12.1	12.5
JUL	29.4	32.2	8.9	15.0	8.6	11.6
AUG	28.8	30.6	6.0	12.1	8.1	11.6
SEP	29.1	28.9	8.0	11.3	12.5	10.7
OCT	21.7	23.3	7.3	10.2	25.0	11.6
NOV	20.7	21.1	9.2	12.5	11.2	13.9
DEC	11.8	13.3	10.8	14.5	12.5	17.0

10M - 10 meter monitoring level  
60M - 60 meter monitoring level

REGN - Regional tower  
MPS - Meters per second

Table 3-8 (*concluded*)  
WVDP and Buffalo Maximum Wind Speeds and Temperatures (1984-1989)

1988 MONTHLY MAXIMUMS						
	WVDP 10M (°C)	BUFFALO (°C)	WVDP 10M (mps)	WVDP 60M (mps)	WVDP REGN (mps)	BUFFALO (mps)
JAN	14.1	16.7	11.1	13.7	12.5	14.8
FEB	10.6	12.8	11.5	12.4	13.4	15.6
MAR	23.7	23.9	7.9	10.3	10.4	13.9
APR	20.9	23.9	7.4	9.6	11.1	14.8
MAY	27.2	27.8	7.9	9.7	9.7	10.3
JUN	32.2	34.4	7.0	10.4	9.2	13.4
JUL	33.6	35.6	5.0	8.3	7.3	10.3
AUG	32.7	35.0	7.2	10.3	9.0	11.6
SEP	25.4	28.3	7.7	9.2	10.2	10.7
OCT	25.3	27.2	7.6	10.6	12.5	13.0
NOV	17.6	19.4	11.7	14.1	11.5	15.6
DEC	11.8	13.3	11.3	13.9	12.1	15.6
1989 MONTHLY MAXIMUMS						
	WVDP 10M (°C)	BUFFALO (°C)	WVDP 10M (mps)	WVDP 60M (mps)	WVDP REGN (mps)	BUFFALO (mps)
JAN	11.6	14.4	9.7	13.0	13.4	18.8
FEB	10.7	13.3	9.1	11.4	11.2	14.3
MAR	24.5	23.3	9.9	12.9	11.6	14.3
APR	18.4	17.8	6.3	9.1	9.2	11.2
MAY	26.7	28.9	7.6	10.3	10.0	10.3
JUN	27.4	29.4	6.4	8.0	7.4	10.7
JUL	29.2	31.7	5.3	8.1	9.1	12.5
AUG	28.1	29.4	5.1	9.2	9.3	11.2
SEP	28.2	27.8	6.9	9.2	8.9	11.2
OCT	24.5	23.3	6.8	9.6	9.5	11.6
NOV	18.6	20.0	10.6	15.0	13.3	16.5
DEC	6.3	6.7	7.5	10.8	10.8	12.5

10M - 10 meter monitoring level  
60M - 60 meter monitoring level

REGN - Regional tower  
MPS - Meters per second

Table 3-9

WVDP and Buffalo Minimum Temperatures (1984 - 1989)  
(°C)

1984 MONTHLY MINIMUM			1986 MONTHLY MINIMUM			1988 MONTHLY MINIMUM		
	WVDP 10M (°C)	BUFFALO (°C)		WVDP 10M (°C)	BUFFALO (°C)		WVDP 10M (°C)	BUFFALO (°C)
JAN	-24.2	-22.8	JAN	-17.9	-18.3	JAN	-23.0	-18.9
FEB	-22.2	-17.2	FEB	-17.2	-13.3	FEB	-19.5	-16.7
MAR	-24.2	-21.1	MAR	-18.5	-16.1	MAR	-20.0	-12.2
APR	-6.1	-2.2	APR	-7.1	-2.8	APR	-4.0	-1.1
MAY	-1.2	2.2	MAY	-2.2	.6	MAY	-1.1	2.8
JUN	4.0	7.2	JUN	-.5	3.3	JUN	-.5	5.0
JUL	5.2	8.9	JUL	4.8	10.6	JUL	4.9	11.1
AUG	6.3	8.3	AUG	1.0	6.1	AUG	3.9	7.8
SEP	.7	3.3	SEP	.4	2.8	SEP	2.3	5.0
OCT	-.6	-2.2	OCT	-4.1	-1.7	OCT	-5.8	-3.3
NOV	-10.1	-8.3	NOV	-8.6	-9.4	NOV	-5.7	-3.9
DEC	-11.1	-12.2	DEC	-13.2	-11.1	DEC	-26.0	-22.2
1985 MONTHLY MINIMUM			1987 MONTHLY MINIMUM			1989 MONTHLY MINIMUM		
	WVDP 10M (°C)	BUFFALO (°C)		WVDP 10M (°C)	BUFFALO (°C)		WVDP 10M (°C)	BUFFALO (°C)
JAN	-26.9	-22.8	JAN	-21.7	-18.9	JAN	-20.1	-16.7
FEB	-17.5	-17.8	FEB	-24.1	-17.8	FEB	-20.4	-15.0
MAR	-14.0	-12.2	MAR	-14.5	-12.2	MAR	-16.4	-15.6
APR	-10.1	-6.1	APR	-6.0	-5.6	APR	-6.3	-5.6
MAY	-2.0	1.7	MAY	-2.5	1.1	MAY	-.9	.0
JUN	3.3	6.7	JUN	4.2	8.9	JUN	5.9	8.9
JUL	6.4	11.1	JUL	9.7	12.2	JUL	8.1	11.1
AUG	7.8	11.1	AUG	6.7	10.6	AUG	6.3	8.3
SEP	.7	5.0	SEP	3.3	6.7	SEP	.4	2.2
OCT	-5.8	-3.9	OCT	-4.0	-1.1	OCT	-1.2	1.7
NOV	-4.8	-2.8	NOV	-12.8	-10.6	NOV	-12.7	-8.9
DEC	-17.8	-14.4	DEC	-15.3	-13.3	DEC	-21.0	-18.3

10M - 10 meter monitoring level

Table 3-10

## WVDP and Buffalo Monthly Precipitation (1985-1991)

	1985 WVDP (inches)	1985 BUFFALO (inches)	1986 WVDP (inches)	1986 BUFFALO (inches)	1987 WVDP (inches)	1987 BUFFALO (inches)	1988 WVDP (inches)	1988 BUFFALO (inches)
JAN	0.98	4.27	2.15	2.31	2.14	2.90	1.73	N/A
FEB	0.50	3.34	2.35	2.60	0.64	0.85	2.15	N/A
MAR	1.79	4.42	1.55	1.95	2.90	3.66	2.58	N/A
APR	1.12	1.33	2.90	3.33	2.24	3.40	3.95	N/A
MAY	2.01	3.46	2.80	4.42	2.07	1.35	2.84	N/A
JUN	3.73	3.21	8.40	4.15	5.22	8.36	1.29	N/A
JUL	3.61	1.81	7.85	2.82	6.18	3.09	3.64	N/A
AUG	2.98	4.63	6.30	2.73	4.68	3.38	4.39	N/A
SEP	2.54	1.20	3.80	3.88	3.39	5.32	3.11	N/A
OCT	5.21	3.73	5.60	4.34	3.17	2.62	4.41	N/A
NOV	7.72	9.75	3.60	3.11	2.94	4.44	3.09	N/A
DEC	2.81	4.85	1.95	4.02	2.71	2.78	2.28	N/A
	1989 WVDP (inches)	1989 BUFFALO (inches)	1990 WVDP (inches)	1990 BUFFALO (inches)	1991 WVDP (inches)	1991 BUFFALO (inches)		
JAN	2.55	N/A	2.46	N/A	1.88	N/A		
FEB	1.84	N/A	4.82	N/A	1.44	N/A		
MAR	1.69	N/A	1.79	N/A	4.91	N/A		
APR	3.72	N/A	4.59	N/A	4.44	N/A		
MAY	5.43	N/A	6.06	N/A	1.67	N/A		
JUN	5.19	N/A	2.08	N/A	0.33	N/A		
JUL	0.99	N/A	3.91	N/A	4.01	N/A		
AUG	1.34	N/A	3.91	N/A	2.76	N/A		
SEP	4.36	N/A	5.64	N/A	3.08	N/A		
OCT	2.47	N/A	8.55	N/A	2.31	N/A		
NOV	4.37	N/A	2.91	N/A	2.38	N/A		
DEC	3.00	N/A	4.32	N/A	3.45	N/A		

N/A - not available

Table 3-11

WVDP and Buffalo Monthly and Annual  
Average Precipitation (1985-1991)  
(inches)

MONTH	WVDP	BUFFALO
JANUARY	1.98	3.16
FEBRUARY	1.96	2.26
MARCH	2.46	3.34
APRIL	3.28	2.69
MAY	3.27	3.08
JUNE	3.75	5.24
JULY	4.31	2.57
AUGUST	3.77	3.58
SEPTEMBER	3.70	3.47
OCTOBER	4.53	3.56
NOVEMBER	3.86	5.77
DECEMBER	2.93	3.88
ANNUAL AVERAGE	39.8	39.5

Table 4-1

Locations and Populations of Towns and Villages  
Partially or Totally within 16 kilometers of the Site

TOWN/ VILLAGE <sup>1</sup>	DISTANCE/ DIRECTION (km)	POPULATION				1960-1970 % CHANGE	1970-1980 % CHANGE	1980-1990 % CHANGE
		1960	1970	1980	1990			
Ashford (T)		1,490	1,577	1,922	2,162	5.8	21.9	12.5
Concord (T)	4.8N	6,452	7,573	8,171	8,387	17.4	7.9	2.6
Springville (V) <sup>2</sup>	5.6N	3,852	4,350	4,285	4,310	12.9	-1.5	0.6
Sardinia (T)	6.4NNE	2,145	2,505	2,792	2,667	16.8	11.5	-4.5
Yorkshire (T)	5.6 NNE	2,012	2,627	3,620	3,905	30.6	37.8	7.9
Delevan (V) <sup>2</sup>	14.4 ENE	777	994	1,113	1,214	27.9	12.0	9.1
Machias (T)	6.4 ESE	1,390	1,749	2,058	2,338	25.8	17.7	13.6
Franklinville (T)	12.5 SSE	3,090	2,847	3,102	2,968	-7.9	9.0	-4.3
Ellicottville (T)	7.7 S	1,968	1,779	1,677	1,607	-9.6	-5.7	-4.2
Mansfield (T)	12.0 SSW	632	605	784	724	-4.3	29.6	-7.7
East Otto (T)	4.8 SW	701	910	942	1,003	29.8	3.5	6.5
Otto (T)	12.0 WSW	715	731	828	777	2.2	13.3	-6.2
Collins (T)	12.0 WNW	6,984	6,400	5,037	6,020	-8.4	-21.3	19.5
North Collins (T)	14.4 NW	3,805	4,090	3,791	3,502	7.5	-7.3	-7.6
TOTAL ALL TOWNS		32,084	33,393	34,724	36,060	4.1	4.0	3.8

<sup>1</sup> (T) indicates town and (V) indicates village.

<sup>2</sup> Village population is included in the respective town.

Source: U.S. Department of Commerce. 1990 Census of Population and Housing. August 1991.

Table 4-2

User Population of Schools  
and Hospitals in Site Vicinity

Facility	Location	Population
Springville High School	7.2 km north	934
Springville Middle School	7.2 km north	631
Springville Elementary School	7.4 km north	736
St. Aloysius Parochial School	6.7 km north	235
West Valley Central School	6.1 km southeast	530
Bertrand Chaffee Hospital	6.9 km north	55

## Source:

West Valley Nuclear Services Co., Inc. August 26, 1996.

Table 4-3

## Local Water Well Inventory Data

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Well No.	Location and Address	Approx. Land Surface Elev. (ft)	Well Use*	Well and Type	Well Diameter	Total Depth (ft)	Interval Screened or Interval (ft)	Probable Aquifer Tapped	No. of People Served	Type of Pump	Static Water Level (ft)	Date of Measurement
1	Thomas Corners Rd.	1130	D,A	Dug	18"	17	3	Gravel	4	Sub.	0.5 Flowing	9/82
2	Thomas Corners Rd.	1300	D,A	Spring					4			9/82
3	Bond Rd.	1245	D,A	Spring					3	S.W.	Flowing	9/82
4	Thomas Corners Rd.	1330	D,A	Dug	36"	12		Sand	0	Piston		9/82
5	Thomas Corners Rd.	1330	D	Auger	4"	12		Sand	2	Piston		9/82
6	Thomas Corners Rd.	1330	D	Well Point	2"	12	4	Sand	3	Piston or Jet		9/82
7	Bond Rd.	1350	D	Spring	cement block holding basin				5	S.W.	Flowing	9/82
8	Bond Rd.	1280	D	Dug	36" steel tube	18		Sand	2	S.W. Jet	1	9/82
9	Bond Rd.	1350	D	Dug	36" concrete tube	15		Sand	4	S.W. Jet	4	9/82
10	Bond Rd.	1310	D	Dug	24" tile	20		Sand	5	S.W.	17	9/82
11	Bond Rd.	1280	D,S,C	Spring	30" x 7' deep fiberglass tank				5	Sub. S.W.	3	9/82
12	Bond Rd. Rt. 240	1310	D,S	Drl	6"	150		Shale	2	Sub.	20.25	9/82
13	Rt. 240	1260	D	Drl	6"	160	30.42	Shale	2	Sub.	17.58	9/82
14	Rt. 240	1345	U	Dug	36"	12-15		Gravel	0		5	9/82
15	Rt. 240	1250	D	Spring						Gravity Fed	Flowing	9/82

\*D = domestic; S = stock; C = commercial; I = industrial; A = agricultural; P = public supply; U = unused;  
 Drl - drilled; Sub - submersible; S&G - Sand and gravel; B.G. - below grade

Table 4-3  
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Well No.	Location and Address	Approx. Land Surface Elev. (ft)	Well Use*	Well and Type	Well Diameter	Total Depth (ft)	Interval Screened or Interval (ft)	Probable Aquifer Tapped	No. of People Served	Type of Pump	Static Water Level (ft)	Date of Measurement
16	Beech Tree Rd.	1300	D	Drl	6"	105	0	Shale	0	Sub	92.66	9/82
17	Beech Tree Rd.	1220	D	Drl					1			9/82
18	Beech Tree Rd.	1220	U	Spring								9/82
19	Watson Rd.	1310	D	Drl	6"	170	8 at 118-126 B.G.	Shale	3	Sub		
20	Watson Rd.			Spring								
21	Watson Rd.	1190	D	Spring					5	S.W.		
22	Watson Rd.	1200	D	Spring	1,000 gal. cement tank				3	S.W.		
23	Beech Tree Rd.		D	Drl	6"	199	162	Shale	3	Sub	89.33	9/82
24	Beech Tree Rd.		U	Drl	6"	167		Shale	0	None	84.66	9/82
25	Beech Tree Rd.		U	Dug	36"	18		Clay/Sand	0	None	0	9/82
26	Watson Rd.	1280	D,S	Drl	6"	200	3	Shale	4	S.W. Jet	0.5	
27	Beech Tree Rd.	1280	D	Well Point	2"	13	4	Sand	4	S.W.		
28	Beech Tree Rd.	1280	D	Dug	2'	10-15		Sand	3	S.W. Jet	0.5	9/82
29	Beech Tree Rd.	1374	D	Spring	Stone Cistern				7	Gravity Fed		
30	Rt. 240	1430	D	Drl	6"	90		Shale	5	Sub	26	
31	Rt. 240	1325	C	Dug		9		S & G	0	Jet	5	

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## Local Water Well Inventory Data

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Well No.	Location and Address	Approx. Land Surface Elev. (ft)	Well Use*	Well and Type	Well Diameter	Total Depth (ft)	Interval Screened or Interval (ft)	Probable Aquifer Tapped	No. of People Served	Type of Pump	Static Water Level (ft)	Date of Measurement
32	Rt. 240	1280	U	Drl	6"	60			0	Jet or Piston		
33	Thomas Corners Rt. 240	1410	D	Drl	8"	65		Shale	3	Sub		
34	Thomas Corners	1380	D	Drl	6"	105	75	Shale	8			
35	Bond Rd.	1345	D	Dug	24" steel tube	12		Sand and Gravel	4	Piston or Rotary		
36	Thomas Corners	1360	D,A	Driven Well Point	1 3/4"	22	4	Sand	7	Rotary		
37	Thomas Corners Rd.	1335	D	Dug Tile Lined	24"	12		Sand	2	Sump	4 assumed	9/82
38	Thomas Corners Rd.	1360	U	Dug and Drilled	3'	40		Sand	0			
39	Emerson Rd.	1330	D	Dug	24" steel tube	12		Sand	2			
40	Emerson Rd.	1330	D	Dug	24" steel tube	12		Sand	2			
41	Emerson Rd.	1340	D	Dug	24" steel tube	12		Sand	2			
42	Rt. 240											
43	Rt. 240	1413	D	Drl	6"	100		Shale	3	Sump		
44	Cole Rd.	1440	D	Drl	6" x 13' steel case	90-105	77-92	Shale	2	Jet		
45	Cole Rd.	1465	D	Drl	6"	100 ± 2	80	Shale	6	Jet	26.75	9/82

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Well No.	Location and Address	Approx. Land Surface Elev. (ft)	Well Use*	Well and Type	Well Diameter	Total Depth (ft)	Interval Screened or Interval (ft)	Probable Aquifer Tapped	No. of People Served	Type of Pump	Static Water Level (ft)	Date of Measurement
46	Cole Rd.	1465	D	Drl	6"	62		Shale	1	Jet		
47	Cole Rd.	1480	D	Drl	6"			Shale	2	Piston		
48	Cole Rd.	1460	D	Drl	6"	60-65		Shale	5	Jet	30.5	9/82
49	Cole Rd.	1460	D	Drl	6"	60		Shale	3	Jet		
50	Cole Rd.	1460	D	Drl	6"	40			3	Sump		
51	Cole Rd.	1550	D	Spring 4' x 11' x 7' Tile Cistern					3	Gravity fed flowing spring		
51a	Cole Rd.	1550	D	Spring					3			
52	Cole Rd.	1530	D	Spring Supplies Both Homes					4	gravity fed		
52a	Cole Rd.	1530	D	Drl					4			
53	Cole Rd.	1480	D	Drl	6"	30-40		Shale	4	Sub		
54	Rt. 240	1460	D	Drl	6"	100	65	Shale	2	Sub	41	9/82
55	Rt. 240	1460	D	Drl	6"	32	12	Shale	5	S.W.		
56	Rt. 240	1450	D	Drl	6"	40			5	Sub	20	1978
57	Bond Rd.	1325	D	Dug	24"	12		Sand	2			
58	Rt. 240	1440	D	Drl	6"	80		Shale	5	Jet	25	1952
59	Rt. 240	1440	D,S	Drl	6"	100	60	Shale	10	Jet	70	1969

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## Local Water Well Inventory Data

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Well No.	Location and Address	Approx. Land Surface Elev. (ft)	Well Use*	Well and Type	Well Diameter	Total Depth (ft)	Interval Screened or Interval (ft)	Probable Aquifer Tapped	No. of People Served	Type of Pump	Static Water Level (ft)	Date of Measurement
60	Rt. 240	1490	U	Drl	6"	73	8	Shale	0	Sub	50.5	11/61
61	Rt. 240	1500	D,A,S	Spring							Gravity fed	
61a	Rt. 240											
62	Rt. 240	1440	D	Drl	6"	129		Shale	8	Jet	27.33	9/82
63	Rt. 240		D	Drl	6"	125		Shale	7	Jet	25	1952
64	Rt. 240	1440	D	Drl	6"	155		Shale	3	Sub	20	1972
65	Rt. 240	1450	D	Drl	6"	160		Shale	4	S.W.	<20	
66	Rt. 240	1460	D	Spring					3	Jet		
67	Rt. 240	1500	D	Drl	6"	130	120-130	Shale	2	Sub	0	
68	Rt. 240	1510	D,S	Drl	6"	98		Shale	4	Sub	12	1956
69	Rt. 240	1490	D	Drl	6"	165		Shale	6	Jet		
70	Rt. 240											
71	Rt. 240	1500	D	Drl	6"	173	43-53	Shale	3	Sub	17.92	9/82
72	Twitchell Rd.	1520	D	Drl	6"							
73	Rt. 240 Green Rd.	1510	D,S	Drl	6"	105		Shale	6	Jet		
74	Rt. 240											
75	Rt. 240	1535	D	Drl	6"	92-96		Shale	4	Jet	66	Spring '73

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Well No.	Location and Address	Approx. Land Surface Elev. (ft)	Well Use*	Well and Type	Well Diameter	Total Depth (ft)	Interval Screened or Interval (ft)	Probable Aquifer Tapped	No. of People Served	Type of Pump	Static Water Level (ft)	Date of Measurement
76	Twitchell Rd.	1570	D,S	Spring					3	Gravity fed	flowing spring	
77	Heinz Rd.	1570	D	Drl	6"	92.4		Shale	3	Jet	58.4	4/28/62
78	Heinz Rd.	1540	D	Spring					3		20	9/82
79	Rt. 240	1550	D	Drl	6"	125						
80	Rt. 240	1550	D	Drl	6"	78			3			
81	Rt. 240											
82	Rt. 240	1450	D	Drl	10"	60		Shale	4	Sub	32	9/82
83	Rt. 240	1560		Drl	8"	90			2	Piston or Jet	10.25	9/82
84	Buttermilk Rd.	1520	D	Spring					3	S.W.		
85	Buttermilk Rd.	1420	D	Drl	8"	110	70	Shale	2	Sub	60	1971
86	Buttermilk Rd.	1520	U	Spring								
87	Fox Valley Rd.	1415	D,S	Drl	6"				3	S.W.		
88	Fox Valley Rd.	1410	D	Drl	6"							
89	Fox Valley Rd.	1450	I	Drl	6"	325		Shale		Sub		
90	Fox Valley Rd.	1450	D,S	Drl	6"	300		Shale	8	Sub	75	Spring '82
91	Dutch Hill Rd.	1890	D	Spring					2	S.W. Jet		
92	Rock Springs	1840	U	Dug	48" wooden box	6		Spring fed				

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Well No.	Location and Address	Approx. Land Surface Elev. (ft)	Well Use*	Well and Type	Well Diameter	Total Depth (ft)	Interval Screened or Interval (ft)	Probable Aquifer Tapped	No. of People Served	Type of Pump	Static Water Level (ft)	Date of Measurement
93	Rock Springs	1840	D	Drl	6"	100	70	Shale	3	Jet	0	9/82
94	Rock Springs		U	Spring								
95	Rock Springs		D,S	Spring					4	Jet		
96	Dutch Hill	1890	D	Drl	6"	90		Shale	7	Sub	41.66	9/82
97	Dutch Hill	1845	D	Dug	36"	15		Silty Sand	5	S.W.		
98	Dutch Hill	1840	D,S	Drl	6"	100	< 60	Shale	7	Jet	25.58	9/82
99	Dutch Hill											
100	Dutch Hill	1790	D	Drl	6"	100	20		4	Jet	6 (est.)	9/82
101	Dutch Hill	1800	D	Dug	24"	5.3	T	Till			2.8	4/62
102	Dutch Hill	1780	D,S	Drl	6"	80	60-70 open	Shale	3	Jet		
103	Dutch Hill	1780	U									
104	Dutch Hill	1780	D						3			
105	Dutch Hill	1710	D,S	Drl	8"	76		Shale	1	Sub		
106	Boberg Rd.	1580	D	Drl	6"	70			1			
107	Boberg Rd.	1580	D	Drl	6"	83			5	Jet		
108	Boberg Rd.	1600	D,S	Spring	Concrete vault 4'x4'x6'				2	S.W. Jet	Over- flows the pipe from the vault	
109	Boberg Rd.	1550	D	Drl	6"	86			2	Sub		

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Well No.	Location and Address	Approx. Land Surface Elev. (ft)	Well Use*	Well and Type	Well Diameter	Total Depth (ft)	Interval Screened or Interval (ft)	Probable Aquifer Tapped	No. of People Served	Type of Pump	Static Water Level (ft)	Date of Measurement
110	Boberg Rd.	1550	D	Drl	6"	50			2			
111	Boberg Rd.	1550	D	Drl	6"	135		Shale	4	Sub	<10	Summer 1980
112	Dutch Hill Rd.	1560	D,A,S	Drl	6"	60	40	Shale	1	Jet	15	1982
113	Dutch Hill Rd.	1560	D	Drl	6"	40	25	Shale	3	Jet	12	1982
114	Dutch Hill Rd.	1595	D	Drl	8"	50			4	Sub	7.33	9/82
115	Dutch Hill Rd.	1640	D,A	Drl	6"	72		Shale	8	Jet	32	1955
116	Cross Rd.	1580	D	Drl	7"	68		Shale	3	Sub	20.5	9/82
117	Cross Rd.	1600	D	Drl	6"	48			2	Jet	34	1980
118	Cross Rd.	1570	D	Drl	6"	30		S & G	5	S.W.	3	1982
119	Cross Rd.	1560	D	Drl	6"	54	42	Shale	2	Sub	17	1980
120	Cross Rd.	1540	D	Drl	6"	50-60		Shale	2	Jet	34.66	9/82
121	Cross Rd.	1480	D	Drl	6"	30			2	Piston		
122	Rt. 12	1490	D	Spring	2,000 gal. tank				4	S.W. Jet	Over-flows observed	9/82
123	Cross Rd.	1450	D	Drl	6"	88	18	Shale	7	Jet		
124	Rt. 12	1440										
125	Rt. 12	1430	D	Dug	36"	18-20			3	Jet		
126	Rt. 12	1450	U	Drl	6"							

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Table 4-3

## Local Water Well Inventory Data

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Well No.	Location and Address	Approx. Land Surface Elev. (ft)	Well Use*	Well and Type	Well Diameter	Total Depth (ft)	Interval Screened or Interval (ft)	Probable Aquifer Tapped	No. of People Served	Type of Pump	Static Water Level (ft)	Date of Measurement
127	Rt. 12	1430	D	Drl	6"	43			2	Jet	10	Spring/82
128	Forks Rd.	1436	D	Dug					5	Jet		
129	Forks Rd.	1430	D,A	Drl		80			2	Jet		
130	Forks Rd.	1430	D	Dug	4'x4' concrete lines	30		Sand	4	S.W.	6	9/82
131	Forks Rd.	1440	D	Well Point	2"	8	4	Sand	5	S.W.		
132	Rt. 12	1425	D	Drl	6"	45			4	Sub	10	8/81
133	Rt. 12	1450	D	Drl	6"	30		Sand-Gravel	7	Jet		
134	Rt. 12	1420	D	Drl	6"	25			7	S.W. Jet	3.5	9/82
135	Rt. 12	1410	D,S	Drl	6"	<30	10	"Clay"	6	Piston	1	9/82
136	Dutch Hill Rd.	1520	D	Drl	6"	85	80	(West) Shale	3	Sub	24.33	8/82
137	Dutch Hill Rd.	1510	D	Drl	6"	85	73	(West) Shale	4	Sub	20	
138	Rt. 12 Dutch Hill Rd.	1385	D	Drl	6"	53			4	Sub	8-12	
139	Autumn View Trail	1420	D	Drl	6"	40			4	Sub	26	1980
140	Schwartz Rd.	1320	D	Dug	36" Ceramic Tile	6		Sand & Gravel	4		0	8/82
141	Schwartz Rd.	1374	D	Drl	8"	56		Sand	2	Centrifugal	7.66	8/82

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Table 4-3  
Local Water Well Inventory Data

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Well No.	Location and Address	Approx. Land Surface Elev. (ft)	Well Use*	Well and Type	Well Diameter	Total Depth (ft)	Interval Screened or Interval (ft)	Probable Aquifer Tapped	No. of People Served	Type of Pump	Static Water Level (ft)	Date of Measurement
142	Schwartz Rd.	1370	D	Drl	6"	53.42		Shale	7	Jet	13	9/82
143	Schwartz Rd.	1374	D	Drl	6"	32		Shale	2	Piston	7.75	8/82
144	Edles Rd.	1370	D	Drl	6"	100	15	Shale	4	Sub		
145	Edles Rd.	1384	D	Drl	6"	70			4	Sub	35	1981
146	Edles Rd.	1320-30	S	Well Point	2"	21		Sand, Gravel	0			
147	Edles Rd.	1320-30	D	Drl	6"	116-140		Shale	2	Sub		
148	Edles Rd.	1285	D	Dug	36" wood encased	21		Sand (clear)	4	Jet	2-3	
149	Schwartz Rd.	1360	D	Drl	6"	100			4	Sub		
150	Schwartz Rd.	1360	U	Dug	6"	40						
151	Rock Springs Rd.	1460	D	Dug	48" Stone Lined	4			2	S.W.	2	9/82

\*D = domestic; S = stock; C = commercial; I = industrial; A = agricultural; P = public supply; U = unused;  
Drl - drilled; - submersible; S&G - Sand and gravel; B.G. - below grade

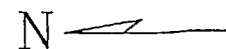
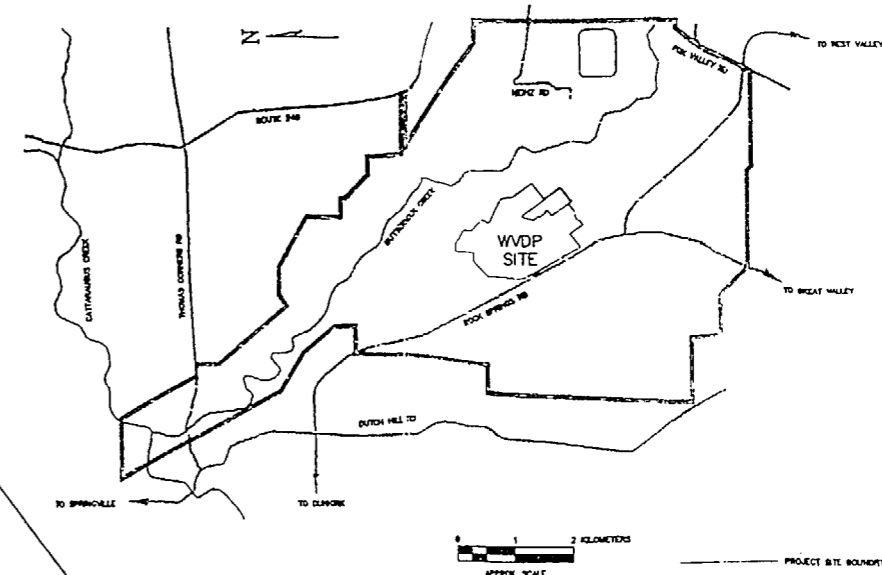


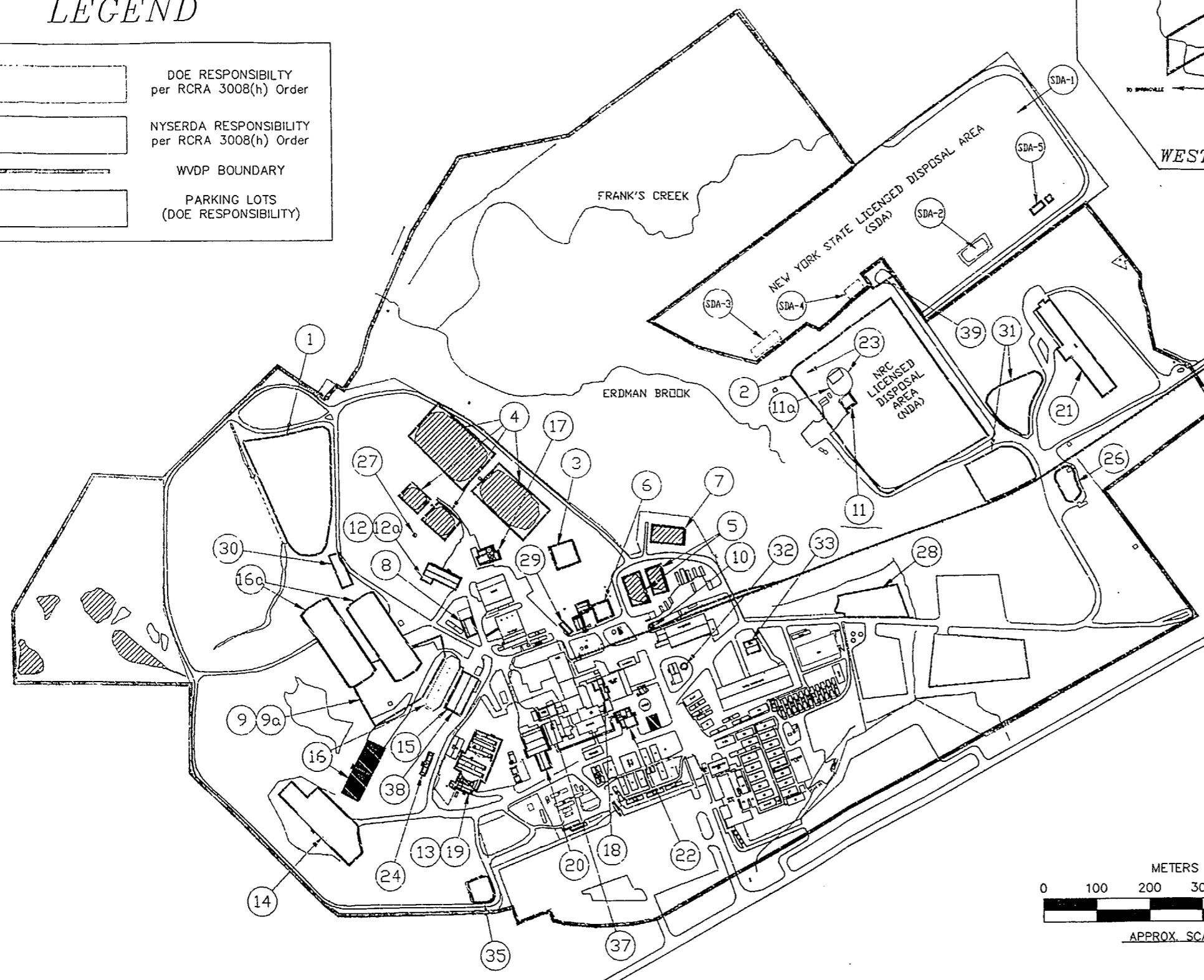
FIGURE 1-1  
WEST VALLEY DEMONSTRATION PROJECT  
SOLID WASTE MANAGEMENT UNITS

LEGEND

	DOE RESPONSIBILITY per RCRA 3008(h) Order
	NYSERDA RESPONSIBILITY per RCRA 3008(h) Order
	WVDP BOUNDARY
	PARKING LOTS (DOE RESPONSIBILITY)



WESTERN NEW YORK NUCLEAR SERVICE CENTER



SWMU	DESCRIPTION	STATUS
#1	CONSTRUCTION & DEMOLITION LANDFILL	NOT ACTIVE
#2	NRC LICENSED DISPOSAL AREA	NOT ACTIVE
#3	LAGOON #1	NOT ACTIVE
#4	LAGOONS #2, #3, #4 AND #5	ACTIVE
#5	SLUDGE PONDS (2)	ACTIVE
#6	SOLVENT DIKE	NOT ACTIVE
#7	EFFLUENT MIXING BASIN	ACTIVE
#8	MAINTENANCE SHOP SANITARY LEACH FIELD	NOT ACTIVE
#9	OLD HARDSTAND STORAGE AREA	NOT ACTIVE
#9a	NEW HARDSTAND STORAGE AREA	ACTIVE
#10	INCINERATOR	NOT ACTIVE
#11	NDA CONTAINER STORAGE	ACTIVE
#11a	STORAGE TANK USED IN TRENCH SYSTEM	ACTIVE
#12	VITRIFICATION FACILITY TEST TANKS	ACTIVE
#12a	VITRIFICATION FACILITY TEST TANKS	ACTIVE
#13	HIGH LEVEL WASTE TANKS	ACTIVE
#14	CHEMICAL PROCESS CELL HARDSTAND	ACTIVE
#15	LAG STORAGE BUILDING	ACTIVE
#16	LAG STORAGE (LSA 1 & 2)	ACTIVE
#16a	LAG STORAGE (LSA 3 & 4)	ACTIVE
#17	LOW LEVEL WASTE TREATMENT FACILITY	ACTIVE
#18	LIQUID WASTE TREATMENT SYSTEM	ACTIVE
#19	SUPERNATANT TREATMENT SYSTEM	ACTIVE
#20	VITRIFICATION FACILITY	ACTIVE
#21	RADWASTE TREATMENT SYSTEM DRUM CELL	ACTIVE
#22	CEMENT SOLIDIFICATION SYSTEM	ACTIVE
#23	TRENCH INTERCEPTOR PROJECT	ACTIVE
#24	HAZARDOUS WASTE STORAGE LOCKERS	ACTIVE
#25	BULK STORAGE W/H SCRAP MATERIAL LANDFILL	NOT ACTIVE
#26	SUBCONTRACTOR MAINTENANCE AREA	ACTIVE
#27	FIRE BRIGADE TRAINING AREA	NOT ACTIVE
#28	VITRIFICATION HARDSTAND	ACTIVE
#29	INDUSTRIAL WASTE STORAGE AREA	ACTIVE
#30	COLD HARDSTAND AREA (NEAR CDDL)	ACTIVE
#31	NDA TRENCH SOIL CONTAINER AREA	ACTIVE
#32	OLD SEWAGE TREATMENT FACILITY	NOT ACTIVE
#33	EXISTING SEWAGE TREATMENT FACILITY	ACTIVE
#34	TEMP. STORAGE LOCATIONS FOR WELL PURGE WATER (NOT SHOWN ON MAP)	ACTIVE
#35	CONSTRUCTION AND DEMOLITION AREA	ACTIVE
#36	OLD SCHOOL HOUSE SANITARY LEACH FIELD (NOT SHOWN ON MAP)	ACTIVE
#37	CONTACT SIZE REDUCTION FACILITY (LOCATED WITHIN THE PROCESS PLANT)	ACTIVE
#38	DRUM SUPER COMPACTOR (LOCATED IN LAG STORAGE BUILDING - SWMU 15)	ACTIVE
#39	STAGING AREA FOR NDA (BRICK WALL)	NOT ACTIVE
#40	SATELLITE ACCUMULATION AREAS AND 90 DAY STORAGE AREA (NOT SHOWN)	ACTIVE
#SDA-1	14 INACTIVE LLRW DISPOSAL TRENCHES	NOT ACTIVE
#SDA-2	INACTIVE LAGOON	NOT ACTIVE
#SDA-3	NORTHERN FILLED LAGOON	NOT ACTIVE
#SDA-4	SOUTHERN FILLED LAGOON	NOT ACTIVE
#SDA-5	TRENCH 14 TREATMENT FACILITY	ACTIVE

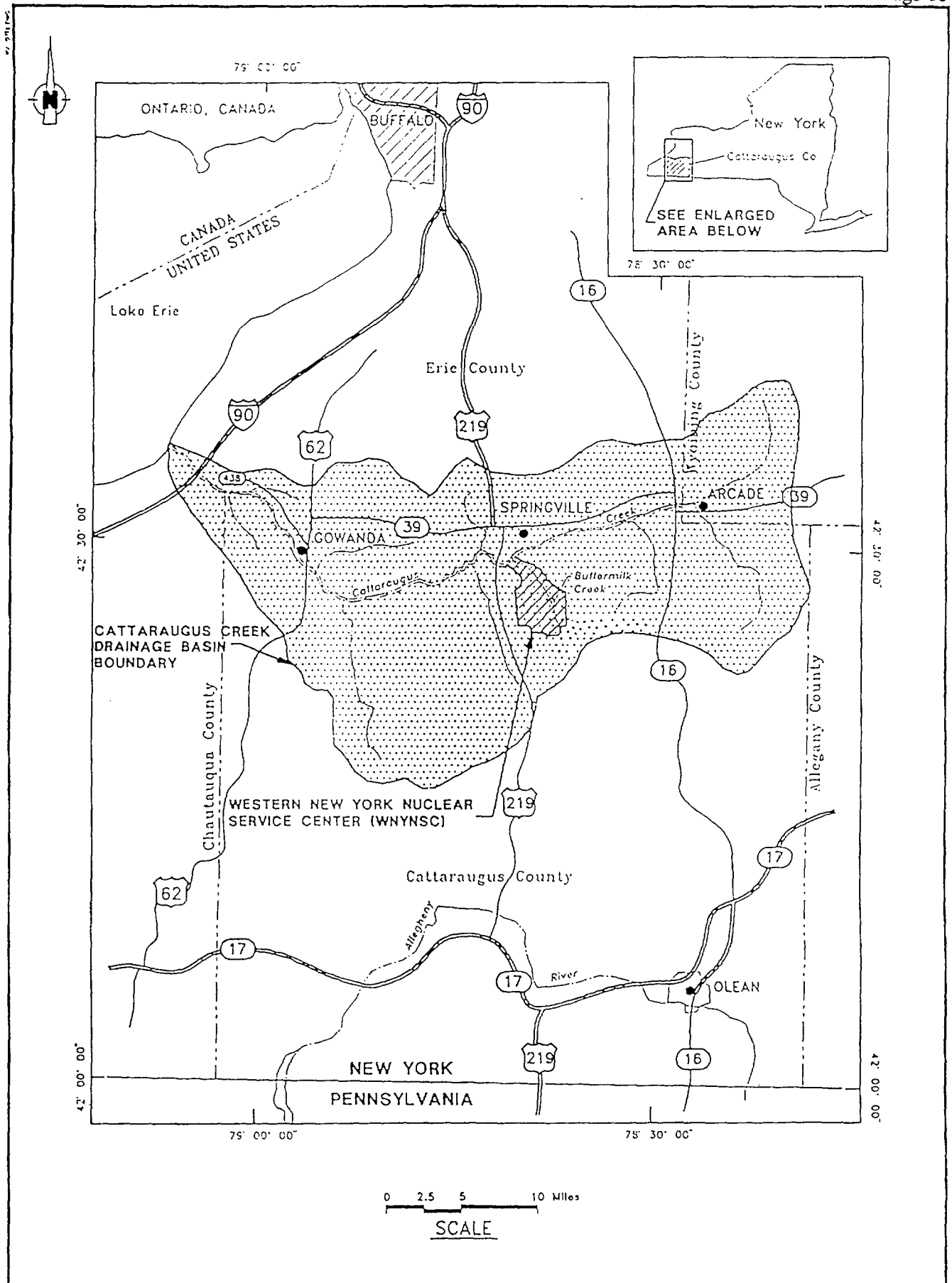


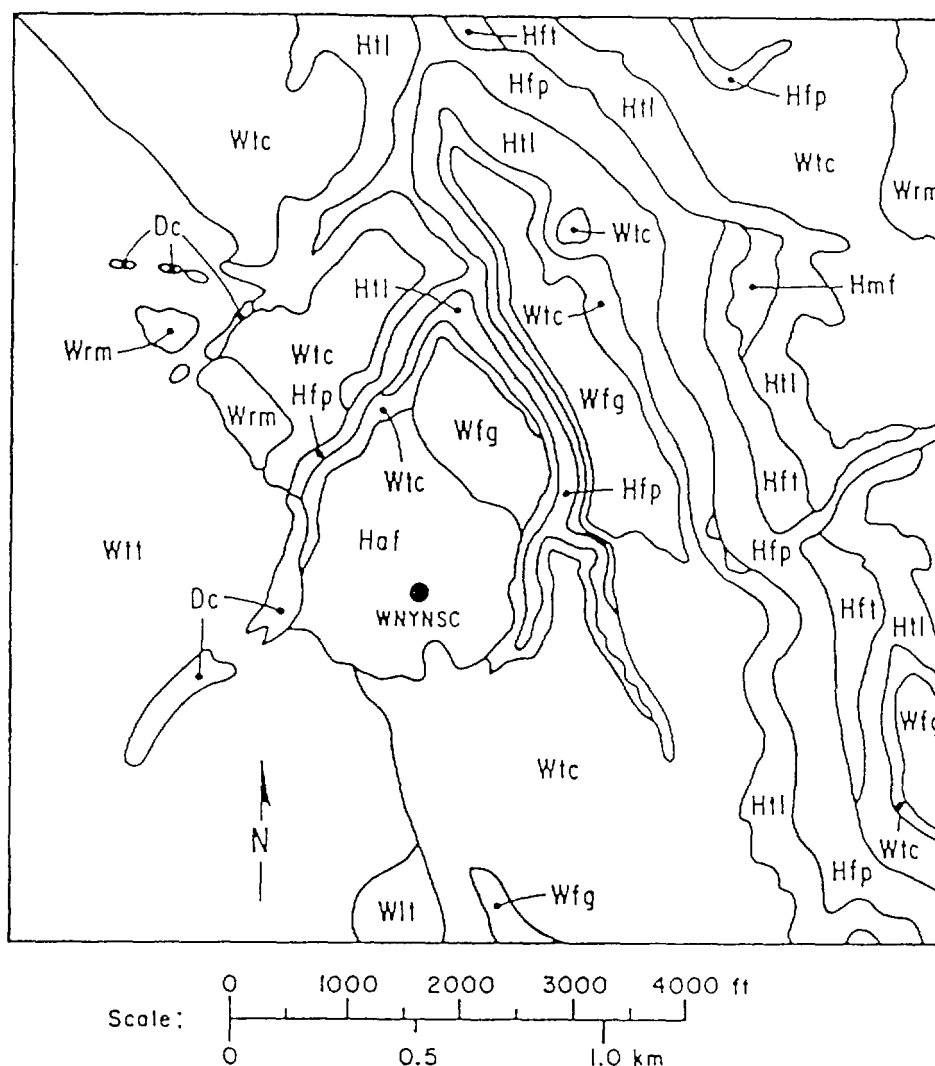
Figure 2-1. Location of the WVDP and the WNYNSC in the Cattaraugus Creek Drainage Basin

SYSTEM	SERIES	UNIT	THICKNESS (m)	APPROX. DEPTH (m)	COLTON'S DIVISION
Quaternary	Holocene	Alluvial fans, floodplain alluvium	0-6	3	
	Pleistocene	Glacial till; fluvial sands & gravels	0-160	30	
Devonian	Upper	Canadaway Group Java & West Falls Group Snyea Group Genesee Group (shales)			DEVONIAN CLASTIC SEQUENCE
	Middle	Hamilton Group (shale & limestone) Onondaga Limestone		648	
Silurian	Upper	Akron - Bertie Salina Group	246		SIL.-DEV. CARBONATE SEQUENCE
	Middle	Lockport Group		894	
		Clinton Group	91		
	Lower	Medina (sandstone)		985	SIL. CLASTIC SEQUENCE
Ordovician	Upper	Queenston Formation (red shales)	492		UPPER ORDOVICIAN CLASTIC SEQUENCE
				1477	
	Middle	Oswego Formation (sandstone)	35	1517	
		Pulaski Formation	175		
		Ulrica Shale	80	1592	
Cambrian	Upper	Trenton-Black River Group	240		CAMBRIAN-ORDOVICIAN CARBONATE SEQUENCE
			NP	1831	
		Little Falls Dolomite	30	1861	
		Theress Formation	205	2066	
Precambrian		Potsdam Formation	52	2118	

LOWER CAMBRIAN  
CLASTIC SEQUENCE

DAMES &amp; MOORE

Figure 3-1. WVDP Site Vicinity Stratigraphic Column



#### LEGEND:

- |     |   |  |
|-----|---|--|
| Hfp | - | Floodplain: gravel, silt alluvium  |
| Hmf | - | Mudflows: Pebbly silt, marginal to floodplains, derived from clayish till (Wtc)  |
| Htl | - | Landslides, slumps: developed on exposures of clayish till (Wtc)   |
| Hft | - | Low terraces of Cattaragus Creek and tributaries; ferruginous gravel and silt, wood-bearing  |
| Haf | - | Alluvial fans: channery gravel, sand   |
| Wfg | - | Fluvial gravel, sand, driven from upland drainage hummocky where laid over thin ice; overlays clayish till (Wtc)   |
| Wtc | - | Till, clayish with pebbles and cobbles; deformed silt stringers, minor overridden pebble gravel, sand; mainly reworked lacustrines. May include Hiram equivalent till in upper few feet. |
| Wrm | - | Ground moraine; mixed stony till, stratified drift; ice marginal   |
| Wlt | - | Lodgment till, >5-ft thick; stony, silty, variously bright and drab  |
| Wtt | - | Lodgment till, <5-ft thick; occasional rock outcrop  |
| Dc  | - | Bedrock outcrop: shales of the Canadaway Group   |

\* Adapted from LaFleur (1979).

Figure 3-2. Surficial Geologic Map of the WVDP Site Vicinity



Figure 3-3. Top of Devonian Bedrock at the WVDP

MAJOR DIVISIONS			GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	
	SAND AND SANDY SOILS	CLEAN SAND (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND-SILT MIXTURES	
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES	
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE					
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS	
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS	
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS	
	MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50			
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS	

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

Figure 3-4. Unified Soil Classification System

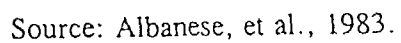
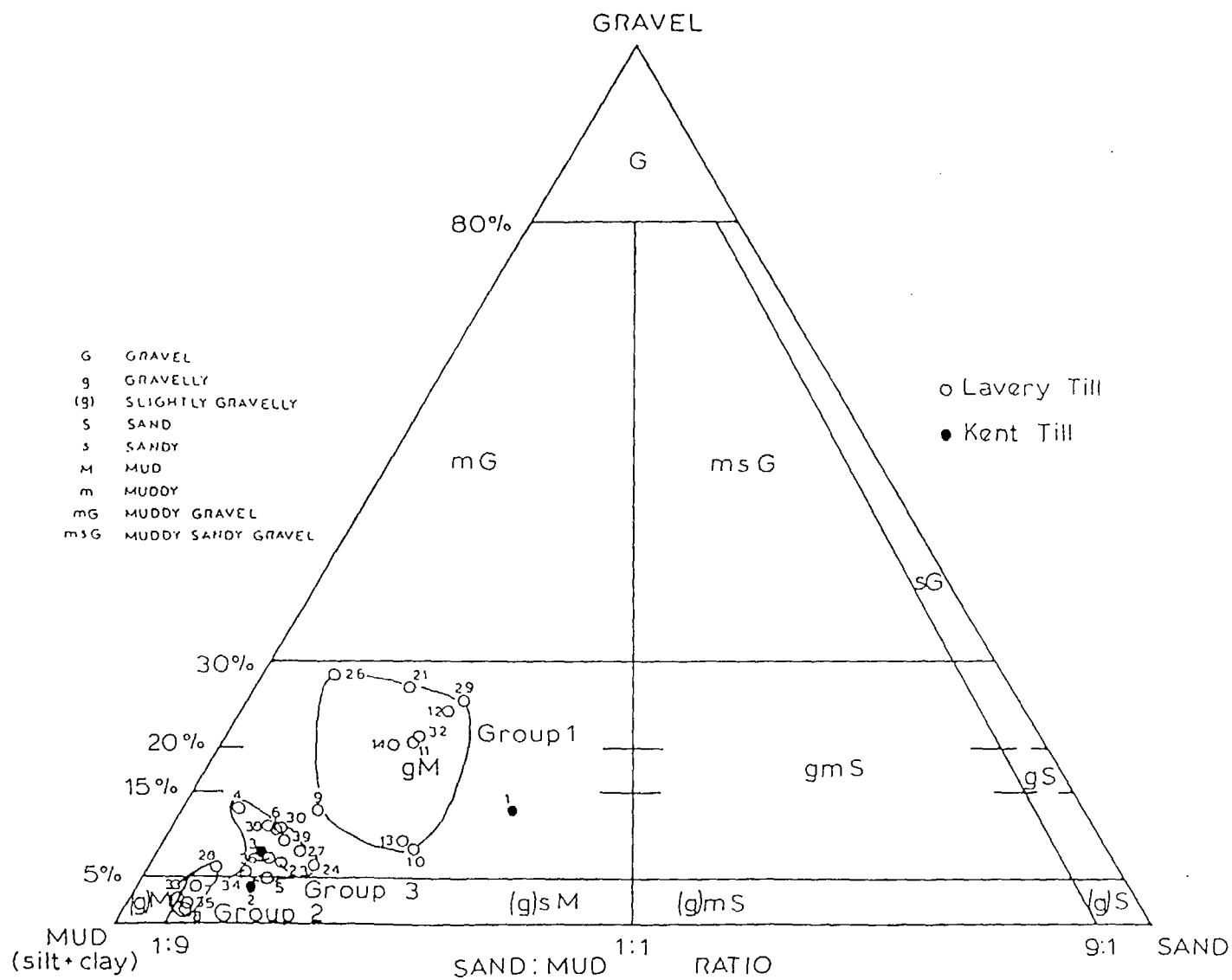


Figure 3-5. Textural Plot of WNYNSC Area Till Samples (1)



Source: Albanese, et al., 1983.

Figure 3-6. Textural Plot of WNYNSC Area Till Samples (2)

DLK9400C:SWATERD.DWG

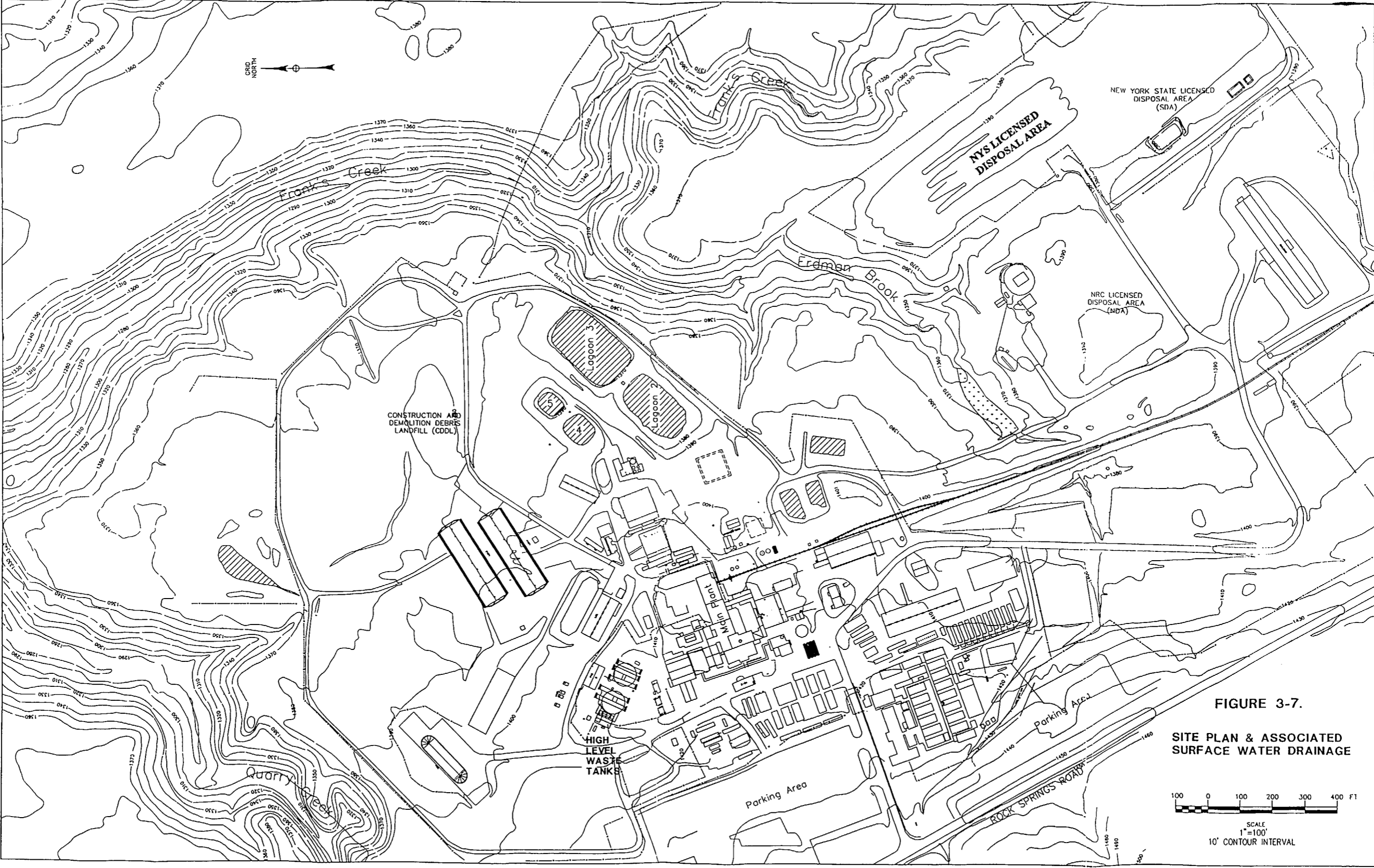


FIGURE 3-7.  
SITE PLAN & ASSOCIATED  
SURFACE WATER DRAINAGE

100 0 100 200 300 400 FT  
SCALE  
1"=100'  
10' CONTOUR INTERVAL

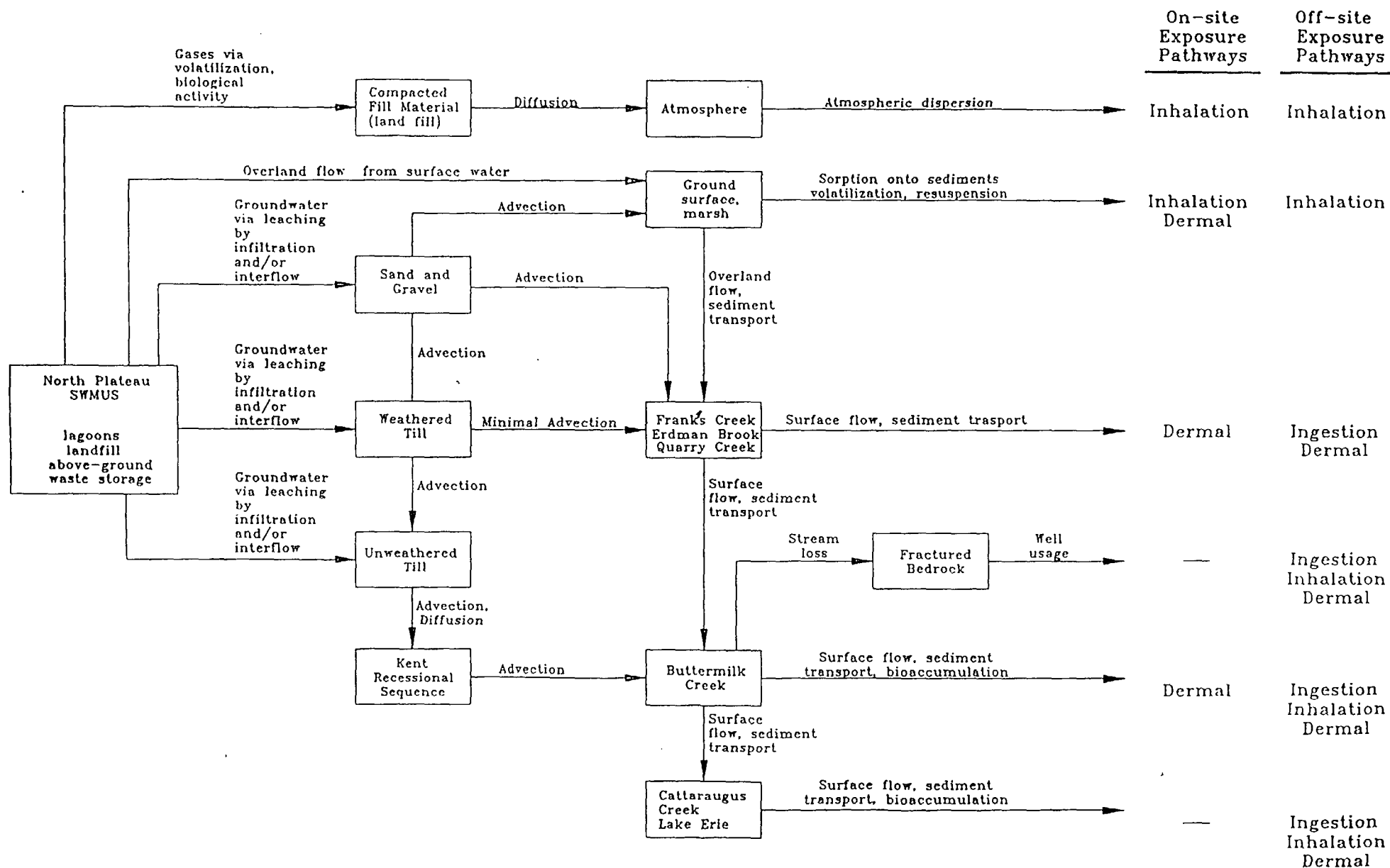


Figure 4-1 Potential Contamination Migration Pathways – Conceptual Model for the North Plateau

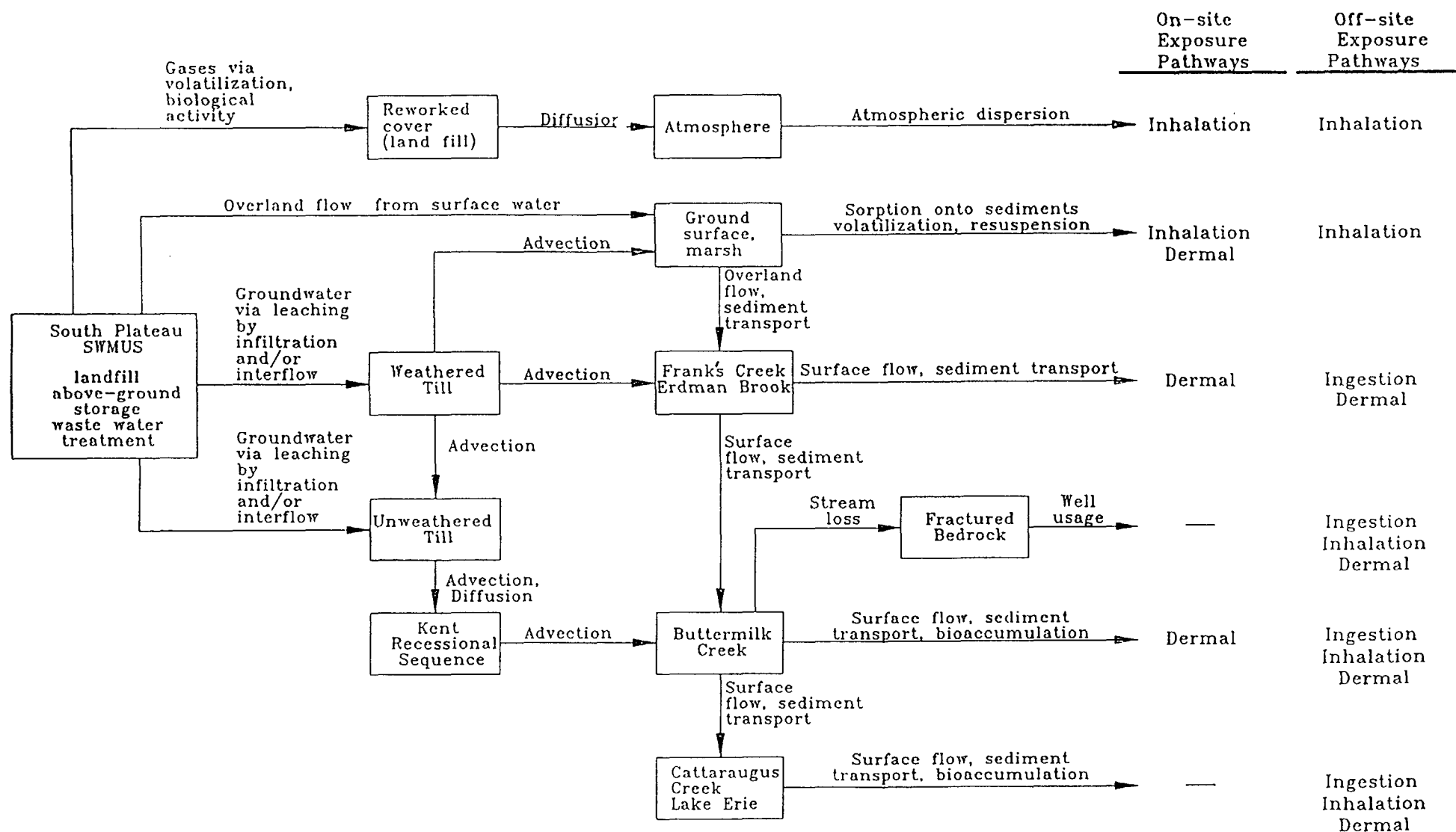


Figure 4-2 Potential Contamination Migration Pathways - Conceptual Model for the South Plateau